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The genus Struthiopteris and its representatives in North America—II*

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(WITH PLATES 26–29)

The bases of the pinnae in the species previously described are fully adnate; in the following species the lower pinnae, at least, are distinctly petioled, except possibly in two species. Usually the upper pinnae are more or less adnate or even somewhat decurrent; when they are free throughout, the fact is definitely stated.

The petioled species, except in *S. Shaferi*, *rufa*, *Underwoodiana*, and *Werckleana*, have somewhat cartilaginous margins; the swollen or glandular vein apices usually give a subserrate to serrate character to this margin. When fully revolute, both the serrate and the cartilaginous character might pass unnoticed; extremes with regard to both of these characters are found in the non-revolute forms, *S. varians* and *S. falciformis*. In such plants as *S. falciformis* the veins could not, of course, be described as "not reaching the margin."

In the non-petioled species the scales are usually confined to the rhizome and the basal part of the stipe. In the following group the basal stipe scales are much more numerous, and similar but smaller ones are found on the rachis and often on the costae. Even the veins of the pinnae may have a delicate araneous covering of minute scales or fibrils. These araneous scales are definitely mentioned when present; the scales of the rachis and costae are not separately described unless they are very numerous or differ greatly from those of the stipe.

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* For part I see Bull. Torrey Club **39**: 257–278. *pl. 21, 22.* 10 Jl 1912.

Most of the petioled species are very large, and complete sterile and fertile leaves are not always found in the same herbarium number; therefore, in this paper the comparative height is often omitted, though it may be more or less accurately deduced from the figures given for the length of the sterile and the fertile fronds, respectively.

Key to the petioled species

B. STERILE PINNAE (AT LEAST THE LOWER ONES) PETIOLED;* RHIZOME SCALES RIGID OR FLACCID; PINNAE MORE OR LESS SCALY; INDUSIUM IRREGULARLY LACERATE TO FIMBRIATE WITH AGE

Rhizome scales very slender, rigidly erect, with dark centers; vestigial pinnae† present; margins entire; coriaceous (rigid-herbaceous in *S. Underwoodiana*).

Sterile lamina very abruptly reduced at the base (type A, with vestigial pinnae); pinnae crowded to overlapping, elliptical, obtuse; dried pinnae rolled and rufous below; margins revolute. 16. S. *rufa*.

Sterile lamina abruptly reduced at the base (type D, with vestigial pinnae except in *S. Shaferi*); pinnae never crowded or overlapping, narrowly oblong to linear, acute to acuminate; dried pinnae not rolled, gray-green to yellowish brown or brown below; margins‡ not revolute.

Apex of the sterile lamina gradually reduced; upper sterile pinnae not conspicuously dilated both ways at the base, the base of the lower ones cuneate, petioled; deciduously araneous below; vein spaces 18–20 to 1 cm.; rachis scales mixed with white, fibrillose ones. 25. *S. Werckleana*.

Apex of the sterile lamina not reduced; upper sterile pinnae conspicuously dilated both ways at their base, the bases of the lower ones barely petioled, rounded; not araneous below; vein spaces 10–16 to 1 cm.; rachis without white, fibrillose scales.

Lower sterile pinnae prominently dilated or auricled at the base; stipes short, 3–10 cm. long, without vestigial pinnae; costae not flattened on the under side; vein spaces 15 or 16 to 1 cm.; indusium light-colored, regularly lacerate to its base, concavely hollowed on the sides of the lacerations. 19. *S. Shaferi*.

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* *S. Underwoodiana* and *S. Shaferi*, the only forms not distinctly petioled, have rigid rhizome scales which are never found in the species in the preceding division.

† Except in *S. Shaferi*.

‡ Incompletely and very narrowly so in *S. Shaferi*, which is peculiarly glandular; see description.

Lower sterile pinnae not dilated or auricled at the base; stipes 18–36 cm. long, with vestigial pinnae; costae flattened on the under side; vein spaces 10–13 to 1 cm.; indusium dark, only occasionally lacerate to the base, not concavely hollowed on the sides of the lacerations. 21. *S. Underwoodiana.*

Rhizome scales broad, flaccid, without dark centers; vestigial pinnae * lacking; margins more or less serrate; membranous to rigid-herbaceous.†

Sterile pinnae with rounded to tapering bases.

Pinnae 2–5-jugate, 4–7.5 cm. long, ovate to ovate-lanceolate, with an acute apex. 13. *S. danaeacea.*

Pinnae 8–25-jugate, 9–26 cm. long, lanceolate to linear, with an acuminate apex.

Margins conspicuously and irregularly erose; stipes red-purple; lamina not reduced at the apex. 22. *S. varians.*

Margins entire to finely serrate; stipes shining straw-colored to dull, pale brown; lamina reduced at the apex in all except the smallest forms. 17. *S. Schiedeana.*

Sterile pinnae with cordate, or rarely subcordate, bases.

Stipes with vestigial pinnae, closely covered with peculiar, appressed, amorphous scales, ordinary scales lacking; viviparous near the apex of the rachis; lamina not reduced at the apex. 24. *S. vivipara.*

Stipes without vestigial pinnae, ordinary scales present, with or without fibrillose or somewhat formless appressed ones; not viviparous; lamina reduced at the apex (except in the smaller *S. striata* specimens).

With red-purple to black stipes; pinnae with an acute (or obtuse?) apex; lower fertile pinnae usually with spurlike protuberances. 23. *S. violacea.*

With straw-colored to chestnut stipes; pinnae with an acuminate apex; lower fertile pinnae usually without spurlike protuberances.

Margins never revolute, but sharply, finely, and regularly cartilaginously serrate throughout. 14. *S. falciformis.*

Margins irregularly or fully revolute, definitely serrate at the apex only.

Stipe scales narrow, short, 2–6 mm. long, projecting; appressed finer ones inconspicuous. 10. *S. chiriquana.*

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* Except in *S. vivipara.*

† Except in the smaller specimens of *S. violacea* and one St. Vincent specimen of *S. striata.*

Stipe scales broad, 1–2 cm. long, flaccid and lying more or less crumpled along the stipe; appressed somewhat formless ones present and numerous in most species.

Sterile pinnae mainly straight; lamina usually 1.5 (rarely 2) times as long as wide; pinnae 6–24-jugate; lower surface with definitely raised veins; margins revolute.

Pinnae 20–24-jugate, the apex acuminate, the base subcordate; lower surface not araneous. 12. *S. costaricensis.*

Pinnae 6–23-jugate (averaging 10–18-jugate), the apex abruptly acuminate, the base fully cordate; lower surface usually finely araneous. 20. *S. striata.*

Sterile pinnae mainly falcate; lamina 2–4 times as long as broad; pinnae 21–70-jugate; veins not raised below (except irregularly so in *S. Christii*); margins rarely fully revolute.*

Sterile stipes chestnut; veins more or less raised below; fertile pinnae occasionally with spurlike protuberances. 11. *S. Christii.*

Sterile stipes straw-colored to brownish; veins not raised below; fertile pinnae without spurlike protuberances.

Sterile pinnae 20–40-jugate; fertile pinnae without a glandular, basal enlargement of the petiole. 15. *S. lineata.*

Sterile pinnae 60–70-jugate; fertile pinnae with a glandular, basal enlargement of the petiole. 18. *S. sessilifolia.*

* Except possibly in *S. sessilifolia;* the condition of the type specimen seen makes it difficult to determine this.

10. **S. chiriquana** Broadh. sp. nov.

Plants terrestrial. Rhizome (not seen) evidently large, the scales lanceolate, 4–10 mm. long, snuff brown to tobacco brown. Sterile fronds 1.7–2.1 m. long; stipes 71–86 cm. long, 1–1.6 cm. thick at the base, angulate, reddish brown to purplish brown, the scales lanceolate, 2–6 mm. long, yellowish to purplish brown, projecting noticeably from the stipe and mixed with smaller, finer ones which are more or less appressed; lamina 106–123 cm. long, 38–45 cm. wide, oblong, slightly reduced at the base (between type B and C * in the normal frond seen, without vestigial pinnae), the apex gradually reduced, the terminal pinna 6.5–9 cm. long, the lower pinnae more or less opposite; pinnae 44–50-jugate, narrowly lanceolate, straight to slightly curved, the apex serrate, long-acuminate, the base subcordate to cordate, the upper pinnae adnate, the lower pinnae sometimes long-petioled (1 cm.), 19–25 cm. long, 2.3–3 cm. wide; margins narrowly revolute;† leaf tissue rigid-herbaceous, the under surface but slightly or not at all araneous, the costae almost naked; veins more or less raised below (not so distinctly as in most specimens of *S. striata*), the vein spaces 12–15 to 1 cm. Sporophyls 1.6 (in young plant)–2.4 m. long; stipes 64–112 cm. long, slightly lighter than the sterile, or yellowish and tinged with reddish brown; lamina 98–124 cm. long, rather gradually reduced at the apex, the base slightly or abruptly reduced; pinnae 49–52-jugate, 15 to 23 cm. long, 3–5 mm. wide, the apex with a sterile tip 3–5 mm. long, the base rounded; sporangia yellowish brown; indusium delicate, very early deciduous, and irregularly lacerate. [PLATE 26.]

Type in the U. S. National Herbarium, no. 676110 to 676114 inclusive, collected in humid forests of the upper Caldera watershed between "Camp I" and the Divide, Holcomb's trail, above El Boquete, Chiriqui; altitude 1650–1925 m., *William R. Maxon 5650*, March 23, 1911.

SPECIMENS INCLUDED: U. S. National Herbarium, no. 675825 to 675828 inclusive, collected in humid forests of Cuesta de Las Palmas, southern slope of Cerro de la Horqueta, Chiriqui, altitude 1700–2100 m., *Maxon 5442* (partly abnormal), March 18, 1911.

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* Bull. Torrey Club **39**: 264. *f. 1.* 10 Jl 1912.

† Irregularly revolute in the abnormal plant, *Maxon 5442*, included in this species. The revolute part is narrow when compared with that in *S. striata*, which has pinnae about equal in width.

Maxon's two plants vary in the bases of the sterile pinnae; in no. 5650 the base is gradually narrowed through a distance of about 2 cm.; in the other, no. 5442, the base is the widest part of the pinna. Excepting also the irregular character of the margin of the latter, the two plants are similar; there is nothing else from the mainland that approaches them in stipe characters, and only one plant (*Tonduz 10907*, the type of *S. sessilifolia*) with such long, numerous pinnae. *S. chiriquana* differs from *S. sessilifolia*, however, in having brightly colored, shining stipes, the upper pinnae partly adnate, straighter pinnae with practically naked costae, and much lighter colored fertile pinnae with very delicate, deciduous indusia.

11. **S. Christii** (C. Chr.) Broadh. comb. nov.

Lomaria spissa Christ, Bull. Boiss. II. 4: 1092. 1904. (Not *L. spissa* Fée.)

Blechnum Christii C. Chr. Ind. Fil. 152. 1905.

Lamina very large; "rachis" 1 cm. thick, red-brown; pinnae 20 cm. long, 2 cm. wide, the apex elongated, the base cordate and sessile, covering and extending beyond the rachis; margins finely dentate with regularly crisped undulations; costae scaly, the scales oval, appressed; veins prominently projecting below. (Sporophyls not described.)

TYPE: In Christ's herbarium; from Costa Rica.

DISTRIBUTION: Apparently limited to Costa Rica.

SPECIMENS INCLUDED: COSTA RICA: Tablaro, "1900 m. VII, '08," *Braveas 143* (N).

Christensen changed the specific name of Christ's *Lomaria spissa* to *Christii*, because Fée had earlier used *L. spissa* for an African species. The very incomplete description given above has been rearranged from Christ's description of *L. spissa*. Following are some additions based upon the sheet from Christ's herbarium mentioned above. The fertile frond is slightly abnormal, having broad sterile tips on some of the pinnae; the following additions have not been incorporated into the description, though a fragment kindly sent by Christ indicates that these smaller fronds are, except in size, decidedly like his specimen.

Sterile frond 52 cm. long; stipe 14 cm. long, and 1 cm. thick at the base, angulate, the scales numerous, deciduous, 1–2.5 cm.

long, yellowish brown, flaccid, loosely appressed, accompanied by small linear or araneous ones; lamina 39 cm. long, 19 cm. wide, ovate-lanceolate, not reduced at the base (type A, without vestigial pinnae), gradually reduced at the apex, the scales smaller on the costae, the under surface finely araneous; pinnae 21-jugate, narrowly lanceolate to linear-falcate, the apex acuminate, serrate, the base cordate, the lowest pinnae petioled; margins slightly and irregularly revolute and therefore appearing subentire; leaf tissue rigid-herbaceous; veins irregularly raised below, the vein spaces 10–12 to 1 cm. Sporophyl (not mature) 64 cm. long, including the stipe; stipe 26 cm. long, lighter in color, partly yellow-brown, otherwise as in the sterile; lamina 38 cm. long, abruptly or not at all reduced at the base, rather abruptly reduced at the apex; pinnae 21-jugate, 9–11 cm. long, 2–3 mm. wide, the base cordate (at least in the lower pinnae), occasionally with spurlike protuberances;* sporangia very dark brown; indusium delicate, narrow, deciduous, subentire, irregularly and not fully lacerate.

12. **S. costaricensis** (Christ) Broadh. comb. nov.

Lomaria costaricensis Christ, Bull. Boiss. II. 4: 1092. 1904.

Blechnum costaricensis C. Chr. Ind. Fil. 152. 1905.

Plants terrestrial. Sterile fronds 60–80 cm. long; stipes at least 30 cm. long, irregularly angulate, straw-colored, the scales lanceolate, 1.5 cm. long, 4 mm. broad, soft, deciduous, mixed with fibrillose ones; lamina at least 41 cm. long, 28 cm. wide, broadly oblong, the rachis somewhat rugose, otherwise like the stipe;† the costae soon becoming naked, leaf tissue rigid-herbaceous, brittle and yellowish green when dry; pinnae 20–22-jugate, straight or slightly curved near their apex, acuminate, the lower ones slightly petioled, and subcordate at the base, 11–22 cm. long, 1.6–2 cm. wide, margins finely serrate or subserrate and somewhat revolute;‡ veins indistinctly raised, the vein spaces 16–20 to 1 cm. Sporophyl § indusium smooth, 2 mm. wide, edge entire but wavy, brown-ochre.

TYPE: In Christ's herbarium.

DISTRIBUTION: Costa Rica and Guatemala.

SPECIMENS INCLUDED: GUATEMALA: Alta Verapaz, Coban, 1350 m., *von Türckheim 1384*, 1907 (Y). Alta Verapaz, "In paludosis prope Coban," altitude 4,300 ft., *von Türckheim 353*, 1879 (N).

* See footnote under *S. violacea*, p. 380.

† But with some whitish, appressed scales in the Guatemalan specimens.

‡ Von Türckheim's specimens from Guatemala are irregularly revolute; so is a pinna sent by Christ. Neither specimen is serrate as in *S. falciformis;* nor so definitely serrate as in any of the species so described in this paper.

§ According to Christ.

The above incomplete description has been rearranged from Christ's with some few additions based on von Türckheim's specimens. The fertile frond forming part of von Türckheim's no. 353 is somewhat mutilated; the two specimens afford the following additions:

Fertile frond 130 cm. long; stipe 60–68 cm. long, light, blotched with brownish, the scales few, yellowish brown; lamina 65–80 cm. long, the pinnae distant; pinnae 16–24-jugate, 13–16 cm. long, 4–5 mm. wide, heavy, with a sterile apex 1–5 mm. long, the bases decidedly cordate; sporangia yellowish brown or dark brown; indusium wavy and entire or irregularly broken, less lacerate than in most of the petioled species.

Christ kindly sent one sterile pinna of *S. costaricensis*. It was evidently one of the upper ones, measuring 10 cm. by 13 mm.; the color is not yellow as in *S. Werckleana*, but a light gray-green characteristic of recent specimens of *S. polypodioides* and common to several of the heavier species of *Struthiopteris;* the vein spaces vary from 16 to 18 to 1 cm.

13. **S. danaeacea** (Kunze) Broadh. comb. nov.

Lomaria danaeacea Kunze, Linnaea **18**: 326. 1844.

Blechnum danaeaceum C. Chr. Ind. Fil. 153. 1905.

Rhizome oblique, very paleaceous with reddish scales. Sterile fronds 10–40 cm. long; stipes clustered, 4–15 cm. long, with appressed scales which are larger toward the rhizome; lamina 8–10 cm. wide, short ovate-oblong, not gradually reduced above, the terminal pinna largest, 6–9 cm. long, often with a basal lobe, shining, lighter below; pinnae 2–5-jugate, ovate-lanceolate to ovate-oblong, the apex serrate, the base rounded, unequally subcuneate, free throughout, sessile, the lower pinnae short-petioled, 4–7.5 cm. long, 1.5–2.5 cm. wide; margins revolute; leaf tissue coriaceous;* costae raised below and chaffy with appressed scales; veins close and distinct. Sporophyls with light-colored, sparsely chaffy stipes; pinnae curved, numerous, long (12–15 cm. in parts of the fertile laminae seen in Kew and Geneva), the apex short-acuminate.

TYPE: Herb. Roemer, no. 121 and 122, from Mexico.

DISTRIBUTION: Known from Mexico only.

SPECIMENS INCLUDED: *Siebold 125* (Delessert Herbarium, Geneva; tracing, N).

* Coriaceous as used here by Kunze and by many of the earlier writers evidently corresponds to rigid-herbaceous as now used.

The incomplete description given above is a translation of the original by Kunze, changed only as to measurements to include some smaller but mature fronds in the Delessert Herbarium at Geneva. Siebold's specimen seen there bears Kunze's name and is evidently a cotype of *L. danaeacea*. Christensen makes *L. deflexa* Liebm. a synonym of *danaeacea;* this it certainly is not, as *deflexa* is described as having *numerous* sterile pinnae. The validity of *Lomaria deflexa* itself might well be questioned, as no type specimen is indicated, and it is founded on a single sterile leaf (a not uncommon practice with Liebmann).

14. **S. falciformis** (Liebm.) Broadh. comb. nov.

Lomaria falciformis Liebm. Vid. Selsk. Skr. V. 1: 234. 1849.
Blechnum falciforme C. Chr. Ind. Fil. 154. 1905.

Plants terrestrial. Rhizome (not seen), the scales lanceolate to ovate-lanceolate, 1–3 cm. long. Sterile fronds 70–150 cm. long; stipes 30–80 cm. long, often angulate, straw-colored to yellowish or reddish brown, varying greatly in the number and in the color of the deciduous scales, which range from straw, tan, and fawn to red-ochre; lamina 35–76 cm. long, 18–32 cm. wide, oblong, abruptly reduced at the base (type A, without vestigial pinnae), gradually reduced at the apex, the scales of the rachis like those of the stipe or darker; pinnae 18–32-jugate, linear or lanceolate, falcate to straight, the lower ones more curved than the upper, the apex acuminate, abruptly so in the widest forms, the base unequally and usually decidedly cordate, the lower pinnae distinctly petioled, 12–23 cm. long, 1.4–2.5 cm. wide; margins never revolute, finely, sharply, and regularly cartilaginously toothed, the teeth usually slanting forward, sometimes incurved; leaf tissue membranous to herbaceous; veins distinct, at least below, not heavy (often appearing as delicate dark lines), the vein spaces 12–15 to 1 cm. (9–12 in one very young frond and also in a single pinna, both determined by Liebmann). Sporophyls (incomplete) at least 65–80 cm. long; lamina 36–40 cm. long; pinnae 11–22 cm. long, 4–5 mm. wide, with a sterile apex 3–12 mm. long, the base cordate, usually petioled; sporangia dark brown; indusium lacerate.

TYPE: Cotypes (?) U. S. National Herbarium no. 474921 (an immature frond determined by Liebmann), "ad rivulos, Chiuautla,"* Mexico, May, 1841. Berlin herbarium (single pinna now in the New York Botanical Garden herbarium) *Liebmann 135*,

* Elsewhere spelled Chiuautata and Chiautla.

Chiuautla, Mexico. In his description, Liebmann attributes this species also to Puebla and Oaxaca, Mexico.

DISTRIBUTION: Mexico and Guatemala.

SPECIMENS INCLUDED: MEXICO: Oaxaca, "Santa Ines del Monte, Zimatlan-Oaxaca Mts.," altitude 3,000 m., *Conzatti 1313* (N). Oaxaca, "Cerro de San Felipe," *Conzatti and Gonzalez 529*, altitude 3,000 m. (N). GUATEMALA: Dept. Chimaltenango, Volcano Acatenango, altitude 8,500 ft., *Kellerman 6481* (N).

Liebmann described *L. falciformis* without seeing the fertile leaf; he probably had a young specimen, for a single pinna of the cotype from Berlin measures 14 cm., and he gives the length of the pinnae as 10 cm. (4 in.). Liebmann speaks of the pinnae as sessile, meaning, apparently, compared with his *L. spectabilis*, for a single sterile frond (U. S. National Museum no. 474921) determined by Liebmann has distinctly petioled lower pinnae. The specimen is apparently very immature. It differs, however, from Liebmann's description in having rounded rather than "obliquely cuneate cordate" bases, elsewhere described by him as unequally angled cordate; the margin of this specimen is *not* fully serrate and is but *slightly* cartilaginous. Notwithstanding these inconsistencies, the very peculiar margin (which does fit the fragment of Liebmann's Berlin specimen) makes it possible to place in this species the plants mentioned above. The Kellerman plant has straighter and proportionately narrower pinnae than the Berlin fragment; it differs still more in this respect from the other specimens included above. More material might make possible its separation.

A plant recently collected in Panama, in "moist ravines above El Potrero camp, Chiriqui Volcano, altitude 2890–3025 m.," *Maxon 5335*, may belong here. The texture is much heavier and the pinnae are shorter and broader than in the other specimens placed in this species; the margin is not quite like that of *S. falciformis*.

15. **S. lineata** (Sw.) Broadh. comb. nov.

Osmunda lineata Sw. Prod. 127. 1788.

Onoclea lineata Sw. Jour. Bot. Schrad. **1800**[2]: 73. 1801; Syn. Fil. 111. 1806.

Lomaria lineata Willd. Sp. Pl. **5**: 290. 1810.

Lomaria procera Spreng. (as used by Jenman and others).

Blechnum capense Diels (in part ?) in E. & P. Nat. Pfl. 1[4]: 249. 1899.

Blechnum lineatum C. Chr. Ind. Fil. 156. 1905.

Plants terrestrial. Rhizome erect, 10 cm. high (see discussion following this description), 3–5 cm. thick, the scales 1–2 cm. long, 2–6 mm. wide, burnt umber to tobacco brown. Sterile fronds 40–155 cm. long; stipes clustered, 18–90 cm. long, angulate, shining or dull, light-colored, or less often bicolored (with brown) or more rarely blotched with brown (purplish brown in some Cuban specimens), the scales numerous, brownish yellow, mixed with more or less fibrillose ones, very loosely appressed, at least toward the rhizome, more numerous than in *S. striata*, the attachment of the larger ones indicated by dark points or raised dots; lamina 28–74 cm. long, 8.5–36 cm. wide, oblong to narrowly lanceolate, slightly or not reduced at the base (type A, without vestigial pinnae), gradually reduced at the apex, the pinnae close to overlapping in the smaller plants; pinnae 18–40-jugate (usually 20–40), linear-oblong, falcate, the apex acuminate, serrate, the base cordate, often partly covering the rachis, often free throughout, the lowest pinnae petioled, 6.5–20 cm. long,* 0.9–2 cm. wide; margins subentire, somewhat cartilaginous, rarely revolute;† leaf tissue herbaceous to rigid-herbaceous, usually somewhat shining below, the costal scales smaller, usually numerous, tan, fawn, and buff, rarely araneous; veins rarely raised below, the vein spaces 13–18 to 1 cm. Sporophyls 92–146 cm. long; stipes 43–85 cm. long (one specimen has a chestnut cast, otherwise like the sterile); lamina 28–66 cm. long, slightly or not reduced at the base, somewhat reduced at the apex; pinnae 24–40-jugate, 8–18 cm. long, 3–4 mm. wide, with a sterile tip 5–10 mm. long, petioled, the lower bases rounded or cordate; sporangia very dark brown; indusium irregularly lacerate.

TYPE LOCALITY: Jamaica.

DISTRIBUTION: Cuba (?), Jamaica, Santo Domingo, and Porto Rico.

SPECIMENS INCLUDED: JAMAICA: Road from Cinchona to Morce's Gap, altitude 5,000 ft., *Underwood 258* (Y). Blue Moun-

* But 5 cm. long in some immature (?) specimens from Cuba; see later discussion for other differences; a fragment from Jamaica consists of but two pinnae which are 42 cm. long. One abnormal specimen from Jamaica, *Underwood 2098*, has pinnae 2.4 cm. wide.

† Two growing plants of *S. lineata* now in the New York Botanical Garden conservatories have pinnae with non-revolute margins, which are narrowly cartilaginous and inconspicuously but sharply and finely serrate.

tain Peak, altitude 6,500–7,325 ft., *Underwood 1446* (Y). Lower slopes of Mt. Moses, moist shaded banks among bushes, altitude 2,000–2,500 ft., *Maxon 1049* (N). Cinchona, altitude 5,000 ft., *Clute 71* (Y, N).

Among these Jamaican plants, as in *S. violacea* and *S. striata*, there occur small but mature specimens differing mainly in size from the larger ones. These smaller plants have narrower laminae (3–4 times as long as broad instead of 2–2.5 times), the pinnae are closer and smaller (4.5–8 cm. long and 6–12 mm. wide as contrasted with pinnae 13–20 cm. long and 15–18 mm. wide); the leaf tissue is much heavier in these smaller forms. As indicated above, a similar range occurs in several other species, and it was not thought best to subdivide them. In this case, however, the rhizome may offer a real distinction. The smaller Underwood plant of *S. lineata* in the New York Botanical Garden conservatories already referred to in a footnote has an *erect* rhizome 10 cm. high and 4–5 cm. thick. The larger *S. lineata* plant incompletely labeled as from Jamaica, though larger in every other way, has a low spreading crown about 7 cm. broad and but slightly raised above the soil.*

Professor L. M. Underwood, who collected a great deal of *S. lineata* in Jamaica, stated that it is "very variable according to soil and light, and especially, age."

The two species, *S. lineata* and *S. striata*, have long been confused. The measurements given by Swartz indicate that in both cases he described small forms. He distinguished between them by describing *striata* (1) as having broader, almost entire, and sessile sterile pinnae, in which the whole apex is serrate; and (2) as having fertile pinnae with dilated cordate bases. A careful study of over thirty sheets from the type localities has shown (1) that many of the *S. lineata* group have fertile pinnae with cordate bases; (2) that the lower pinnae of *striata* are petioled; and (3) that the tips are serrate in most of the *lineata* group, also. Never-

* Other differences, which correspond to those found in herbarium specimens, are as follows: the smaller plant has stipes 15–17 cm. long, laminae 25–35 cm. long and 13–14 cm. wide, close to overlapping pinnae, which are 16–20-jugate, with the terminal pinna 6–7 cm. long; the larger plant has stipes 45–60 cm. long, more or less blotched with brown, laminae 45–60 cm. long and 20 cm. wide, pinnae not close, 25–27-jugate, with a terminal pinna 9–11 cm. long.

theless it is easy to select single plants from these localities which will justify the distinctions made by Swartz. Abundant material from these localities separates readily according to distribution, showing the following differences, mainly relative but sufficient to separate them. *S. lineata* has narrower sterile laminae and narrower, more numerous pinnae, which are more curved, not abruptly but gradually acuminate, shining below, and less revolute. The scales in *S. lineata* are more numerous and more persistent; they are mixed with finer and shapeless ones, which are more or less appressed to the stem; the costae contrast markedly with the commonly naked ones of *S. striata*, as do the smoother, often shining, under surfaces of the pinnae with the finely araneous condition of the strongly raised veins on the under surface of *S. striata*. A plant from Santo Domingo (*Eggers 2041*, "monte Barrero," altitude 1,100 m.) has very heavy, more numerous (58-jugate), narrow, close pinnae with deeply cordate bases; the rachis is densely chaffy and also fibrillose, and the scales on the costae are numerous, more uniform, and heavier in texture. More material might make possible its separation from *S. lineata*.

Some recent material from Cuba, collected by J. A. Shafer at Oriente (no. 4150 and no. 9038), shows plants with very narrow fronds, and narrow pinnae which (when fully mature) are heavier than any of the *S. lineata* specimens seen, except the plants mentioned above collected by Eggers. Shafer's no. 8059, also from Oriente, is like *S. lineata* in the narrow lamina but has short and proportionately broad pinnae (suggesting *S. striata*, in proportion only); as in *S. lineata*, the margins are subentire to almost serrate, not revolute, and the veins are not raised below; the scales throughout are more like those of *striata;* the stipes are dark reddish brown and the rachises similar. More material from Cuba is most desirable; excepting *S. Shaferi* these are the only Cuban representatives of the petioled species.

16. **S. rufa** (Spreng.) Broadh. comb. nov.

Lomaria rufa Spreng. Nova Acta **10**: 230. 1821; Syst. **4**: 63. 1827.

Lomaria robusta Fée, Gen. Fil. 69. 1852.

Plants terrestrial. Rhizome subarboreous (in *Duss 4164*, 20 cm. long and 12 cm. thick), the scales 2.5–3.5 cm. long, linear, 1–2

mm. wide, rigidly erect, dark tobacco brown or burnt umber with definite lighter margins. Sterile fronds 30–58 cm. long; stipes 9–20 cm. long, more or less irregularly angulate, marked throughout by vestigial pinnae, dull brownish, not shining, the scales like those of the rhizome, but shorter, less numerous, and abruptly wider at the base, mixed with finer, soft, light brown to rufous ones, the position of the fallen scales plainly indicated as in *S. lineata;* lamina 28–40 cm. long, 13–20 cm. wide, elliptical to oblong, abruptly reduced at the base (type A, with vestigial pinnae) gradually reduced at the apex, terminal pinna 4–7 cm. long, the pinnae crowded to overlapping, the lower often deflexed (at least in dried specimens), the rachis scales mixed with more numerous, fine or fibrillose, matted scales; leaf tissue very heavy and coriaceous, becoming rolled and rufous below in drying, the costae more or less fibrillose, the under surface usually araneous with similar yellowish to rufous scales (the upper surface of the costae occasionally slightly fibrillose also); pinnae 12–25-jugate, elliptical to oblong, the apex obtuse, appearing acute in some "rolled" specimens, the base rounded, short-petioled in the lower pinnae, 6–10 cm. long, 17–27 mm. wide; margins revolute; veins not raised below, sometimes rather distinctly grooved above, the vein spaces 13–18 to 1 cm. Sporophyls taller, 67–114 cm. long; stipes 15–57 cm. long; lamina 33–60 cm. long, abruptly reduced at the base, slightly reduced at the apex; pinnae 20–35-jugate, thick or heavy, 15–16 cm. long, 5–6 mm. wide, the petioles heavy; sporangia dark brown; indusium quite regularly lacerate. [PLATE 28.]

TYPE LOCALITY: "Islands of the Caribbean."

DISTRIBUTION: Guadeloupe only, apparently.

SPECIMENS INCLUDED: GUADELOUPE: "Plateau de la Soufrière (autour du lac de soufre), 1895," altitude 1,420 m., *Duss 4164* (Y, N); U. S. National Museum no. 524499, *Duss. L'Herminier 27* (Geneva; tracing, Y).

Fée himself says that his *Lomaria robusta* is near *L. rufa* Spreng.; and the rufous, oblong, obtuse, coriaceous pinnae of Sprengel's description, described from the islands of the Caribbean, are so characteristic that there seems to be no reason for disregarding the older name of *rufa*.

17. **S. Schiedeana** (Presl) Broadh. comb. nov.

Lomaria Schiedeana Presl, Linnaea **5**: 613. 1830; Tent. 143. 1836.

Lomaria longifolia Schlecht. Mém. Acad. Brux. **15**: 49. 1842.

Lomaria spectabilis Liebm. Vid. Selsk. Skr. V. **1**: 235. 1849.

Lomaria acrodonta Fée (?), Mém. Foug. **8**: 70. 1857.

Blechnum ornifolium C. Chr. (in part). Ind. Fil. 157. 1905.

Plants terrestrial. Rhizome (not seen), the scales (in Guatemalan species at least) large, 2.5–3 cm. long, 5–10 mm. wide, more or less plicate, burnt umber. Sterile fronds 1.1–2 m. long; stipes 70–80 cm. long, irregularly angulate, light-colored (and shining in the Guatemalan species), the scales yellowish brown to snuff-colored, very deciduous; lamina 45–86 cm. long, 20–50 cm. wide, oblong, but slightly or not at all reduced at the base (type A, without vestigial pinnae), gradually reduced at the apex (except in the smallest forms which are not reduced),* the rachis with few scales and usually fibrillose in the channel; pinnae 18–25-jugate (8–15 in the smaller forms), lance-oblong, straight or somewhat curved (falcate in the smaller forms), the apex serrate, acuminate to long-acuminate, often abruptly so, the base rounded or even tapering (the pinnae all free in the smaller fronds), the lower pinnae long-petioled, 24–36 cm. long (9–15 in the smaller forms), 1.8–3 cm. wide; margins entire to finely serrate, more or less cartilaginous; leaf tissue membranous to herbaceous or barely rigid-herbaceous, the surface sometimes shining, the costae finely fibrillose or naked; veins† not raised, but distinct below, the vein spaces‡ 13–18 to 1 cm. Sporophyls 50–160 cm. long; lamina 38–100 cm. long, slightly or not at all reduced at the base, gradually reduced at the apex; pinnae 15–26-jugate, 8–20 cm. long, 3–5 mm. wide, with a sterile tip 2–5 mm. long, more or less petioled; sporangia dark brown; indusium delicate, narrow, and sparingly lacerate.

TYPES: 1. (*Lomaria Schiedeana*) Mexico, *Schiede 781* (Berlin; fragments and tracing, Y). 2. (*Lomaria longifolia*) Mexico, Cordilleras, Vera Cruz, altitude 4,000 ft., *H. Galeotti 6406*, 1840 (Kew and also Delessert Herbarium, Geneva; tracings, Y).

DISTRIBUTION: Apparently confined to Mexico and Guatemala.

SPECIMENS INCLUDED: MEXICO: Herb. Rovirosa, no. 846, Chiapas, "Habitat inter pago San Bartolo et Las Nubes," alti-

* The type of *L. Schiedeana* is a small plant and is not reduced at the apex.

† The vein apices are so swollen in one Guatemalan plant that the true cartilaginous margin seems almost intramarginal.

‡ Vein spaces 14–16 in the type of *S. Schiedeana* and in all the larger specimens, except possibly the Galeotti specimens.

tude 1,400 m. (Y). Totutla, *Liebmann*, U. S. National Museum no. 591311. GUATEMALA: Guatemala (Dept.), altitude 4,500 ft., *J. D. Smith 2427* (N). Alta Verapaz, "Sumpfiger Boden bei Coban," altitude 4,300 ft., *von Türckheim 353** (N).

Liebmann published *L. spectabilis* to include the earlier *L. longifolia* Schlecht. and *L. Schiedeana* Presl. He considered *L. longifolia* † invalid because that specific name had been previously used for a twining species. The description consists merely of the name, the type number (*Galeotti 6406*), the height (5–6 ft.), and the habitat (borders of "ruisseaux"). *L. Schiedeana* was little more than a name, as Liebmann states. It, also, however, was accompanied by a type number, *Schiede 781* (herb. no. 19849), and the statement that it differed from *L. striata* in having an elliptical-obtuse instead of a subcordate base.

Galeotti's specimens, seen in Kew and Geneva, seem at first quite different from the fragments and partial tracings of the type of *Lomaria Schiedeana*. The latter is smaller, more membranous, and the pinnae are more curved. Liebmann says that Schiede found but fragments of the sterile frond. At all events the differences are no greater than in the plants included in *S. striata;* in fact, the range in the apical reduction of the frond and in the shape and number of the pinnae is about the same.

Our material representing *S. Schiedeana* is very scanty; Liebmann had the advantage of knowing this region, and there seems to be no strong reason for not accepting his conclusion that *Schiedeana* and *longifolia* should be united. Both names were based on numbered type specimens; *longifolia* is, as Liebmann points out, a homonym; *Schiedeana*, however, was published twelve years earlier and is therefore the rightful name of the species, and Liebmann's name *spectabilis* is reduced to a synonym of *S. Schiedeana*. Liebmann's own sheets of *spectabilis* (U. S. National Museum no. 591311 and 591312) do not have the shining surface mentioned in his description of *L. spectabilis*. Otherwise, except for their smaller size, they seem to be very like the larger specimens included in *S. Schiedeana*.

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* Not the same as *von Türckheim 353* under *S. costaricensis*.

† *Lomaria longifolia* Kaulf. 1824; since transferred to *Stenochlaena;* var. 2 of *S. sorbifolia*, according to Christensen.

Christensen makes these three names (*Schiedeana*, *longifolia*, and *spectabilis*) synonyms of *Lomaria ornifolia** Presl. Presl published *L. Schiedeana* five years after *L. ornifolia;* in comparing them he described *ornifolia*, thought to be from Peru, as differing in having obliquely cordate bases; *Schiedeana* he elsewhere described as having elliptical-obtuse, not subcordate, bases. There seems therefore no reason for adopting *S. ornifolia* as the specific name for these plants which possess rounded to almost tapering bases.

Fée's *L. acrodonta* has apparently an abnormal fertile frond; not having access to the type, *Schaffner 102*, 1854, I see no valid reason for separating it from *S. Schiedeana*, especially as the description contains contradictory statements as to size. In the Rovirosa specimen included in *S. Schiedeana*, the fertile frond has in two places a pair of fertile pinnae instead of the usual single pinna. Such abnormality has not been noticed in any other species of *Struthiopteris*.†

18. **S. sessilifolia** (Klotzsch) Broadh. comb. nov.

Lomaria sessilifolia Klotzsch; Christ, Bull. Boiss. II. **4**: 1092. 1904.

Blechnum sessilifolia[*um*] C. Chr. Ind. Fil. 159. 1905.

Plants‡ terrestrial. Rhizome (not seen). Sterile fronds 1.5 m. long; stipes 50–82 cm. long, angulate, dull brownish, the scales lanceolate, 1.5–2 cm. long, 2–4 mm. broad, dull brownish, ragged (according to Christ, reddish straw-colored, very soft, and thread-like); lamina 96 cm. long, 29 cm. wide, oblong, not at all or but slightly reduced at the base (type A, without vestigial pinnae), very gradually reduced at the apex, the pinnae crowded, often opposite, the rachis grayish brown, with dull brownish, fibrillose, more or less appressed, and deciduous scales; pinnae 58–70-jugate, linear-oblong, mostly falcate, the apex attenuate, serrate, the base cordate, free throughout, and partly covering the rachis, 13–15 cm. long, 20 mm. wide; margins irregularly revolute; leaf tissue herbaceous (much rolled in the poorly preserved cotype seen), not araneous below, the costal scales lanceolate or ovate-lanceolate, light brown, rather numerous;

* Rel. Haenk. **1**: 51. 1825.

† See the discussion under *S. violacea* of spurlike growths at the bases of the fertile pinnae in some species of *Struthiopteris*, p. 380.

‡ This description is chiefly from the U. S. National Museum cotype of *L. sessilifolia*.

veins slightly grooved above, appearing below as distinct, fine lines slightly but not definitely raised, the vein spaces 10–13 to 1 cm., the vein apices often marked by delicate, irregular, deciduous, scalelike growths. Sporophyls at least 100 cm. long; stipe over 22 cm. long (complete stipe not seen); lamina 80 cm. long; pinnae about 60-jugate, 12–15 cm. long, 3–4 mm. wide, the apex with a sterile tip 2–4 mm. long, the base distinctly cordate and petioled, the petioles bearing throughout glandular swellings at the upper side where they join the rachis;* sporangia dark brown; indusium not very heavy, irregularly but quite fully lacerate, apparently quite persistent.

Cotype in the U. S. National Museum, no. 472015, 472016, collected "Sommet du Volcan de Poas," 2,644 m., Costa Rica, *Tonduz 10710*, November 1896.

If not distinct, this could well be considered a mainland form of *S. lineata*. It differs as indicated in the key, and also in having many more pinnae. The only island specimens of *S. lineata* having more than 40 pinnae are the peculiar ones from Santo Domingo which were mentioned under *S. lineata* as quite different from the rest of that species; they, however, do not resemble this plant collected by Tonduz, as they are much heavier in texture and have much narrower laminae.

19. **S. Shaferi** Broadh. sp. nov.

Plants terrestrial. Rhizome evidently large, the scales 1.5–2 cm. long, tufted, rigidly erect, linear, broader at the base, often abruptly so, yellowish brown with a definite dark brown center. Sterile fronds 32–42 cm. long; stipes 3–10 cm. long, smooth to somewhat angulate, straw-colored to brownish, the scales much as on the rhizome, shorter, loosely arranged or disappearing with age; lamina 16–35 cm. long, 14–18 cm. wide, oblong or broadly elliptical (young oblanceolate), abruptly reduced at the base (type D, without vestigial pinnae), usually not reduced at the apex, the terminal pinna 7–11 cm. long, the rachis with much smaller scales or naked; pinnae 10–15-jugate, narrowly oblong to almost linear, straight to somewhat falcate, ascending, 8–11 cm. long, 10–15 mm. wide (through the dilation or auricle), the apex acuminate, entire, the base broadly dilated and fully adnate to the rachis in the upper pinnae, in the lower ones narrowed suddenly below the expansion or auricle on the lower side of the pinna and

* Each petiole has therefore a peculiar shouldered appearance; a few of the lower sterile pinnae have the same glandular expansion of the petiole.

barely petioled; margins incompletely and very narrowly revolute, entire,* not cartilaginous, finely glandular with stalked glands;† leaf tissue coriaceous, gray-green or sometimes when dried yellowish brown, much as in *S. Werckleana*, the costal scales smaller or lacking; veins not raised, indistinct, not swollen at their apices, the vein spaces 15 or 16 to 1 cm. Sporophyls 67 cm. long;‡ stipes 18 cm. long; lamina 47 cm. long, abruptly reduced at the base, not reduced at the apex; pinnae 19-jugate, with a sterile apex 1–2 mm. long, the base decurrently adnate in the upper pinnae, sessile in the lower ones and rounded to cordate, 9.5–11 cm. long, 2–3 mm. wide; sporangia brownish yellow; indusium cartilaginous, fully and regularly lacerate to the base, the sides of the lacerations concavely hollowed, the edges finely fimbriate. [PLATE 27.]

Type in the New York Botanical Garden herbarium, collected at Camp La Gloria, south of Sierra Moa, Oriente, Cuba, *J. A. Shafer 8106*, Dec. 24–30, 1910.

20. **S. striata** (Sw.) Broadh. comb. nov.

Onoclea striata Sw. Syn. Fil. 304; 422. 1806.

Lomaria striata Willd. Sp. Pl. **5**: 291. 1810.

Lomaria Ryani Kaulf. Enum. Fil. 155. 1824.

Lomaria brasiliensis Raddi (?), Pl. Bras. **1**: 50. *pl. 72, 72 bis.* 1825.

Lomaria tuberculata J. Sm.§ Cat. Kew Ferns. 1856.

Blechnum capense Diels (in part), in E. & P. Nat. Pfl. 1^4: 249. 1899.

Blechnum striatum C. Chr. Ind. Fil. 160. 1905.

Plants terrestrial. Rhizome at least 2.5 cm. thick, the scales 2–3 cm. long, 2–4 mm. wide, varying from dark fawn to burnt umber. Sterile fronds 35–125 cm. long; stipes 15–74 cm. long, clustered, angulate, usually light-colored, dull to shining, the scales lighter, otherwise as on the rhizome, very deciduous, fewer shapeless ones among them than in *S. lineata* or none at all, the

* Wholly entire; not even subserrately margined by the swollen vein apices. In this *S. Shaferi* affords a marked contrast to all the petioled species previously described.

† Numerous, tiny, stalked glands are found on the revolute margin. Nothing of the kind has been observed in any other specimens included in this paper. This material is fresher than any other seen (collected in 1911), and this fact may account for the presence of the glands. Conservatory specimens of *S. Underwoodiana*, to which *S. Shaferi* is most nearly related, do not possess similar glands.

‡ All of the following measurements refer to the single fertile frond seen.

§ According to Smith himself; Cat. Ferns Br. Gard. 40. 1857.

position of the fallen ones marked by points as in *S. lineata*; lamina 22–71 cm. long, 12–35 cm. wide, broadly lanceolate to broadly oblong (broadly ovate or elliptical in the smaller plants), not at all or slightly reduced at the base (type A, without vestigial pinnae), usually reduced gradually at the apex, not reduced in the smaller forms; pinnae 7–20-jugate, lanceolate to lance-oblong, straight or slightly curved in the outer half or near their apex (falcate in some of the smaller fronds only), 8–20 cm. long, 1.8–3 cm. wide, tapering gradually, if slightly, to the abruptly acuminate, serrate apex, the lower pinnae petioled, the base decidedly cordate; margins revolute; leaf tissue rigid-herbaceous to coriaceous,* the costae scaly, fibrillose, or naked, the under surface delicately but often fully araneous on the raised veins; veins distinct, definitely raised below, the vein spaces 12–16 to 1 cm. Sporophyls 40–175 cm. long; stipes 24–118 cm. long; lamina 48–64 cm. long (16–23 in the smaller forms), reduced at the apex, but slightly reduced at the base; pinnae 15–27-jugate (7–15 in the smaller forms) with a sterile tip 5–10 mm. long which is often serrate, the lower petioled and cordate at the base, 7–18 cm. long, 3–6 mm. wide; often whitish-knobbed at the vein ends as in *S. vivipara;* sporangia yellowish brown to dark brown; indusium irregularly lacerate, often to the base.

TYPE LOCALITY: Martinique, St. Kitts (St. Christopher).

DISTRIBUTION: St. Kitts, Montserrat, Guadeloupe, Dominica, Martinique, St. Vincent, and Grenada.

SPECIMENS INCLUDED: ST. KITTS: Forest slopes of Mt. Misery, *Britton & Cowell 511*. GUADELOUPE: (Definite locality not given), altitude 700–900 m., *Duss 4353* (N, no. 524250; Y). DOMINICA: Laudat, *Lloyd 190* (small form, Y). MARTINIQUE: "Bois de la montagne," Pelée, altitude 600–1,000 m., *Duss 1555* (N, no. 524242, 524243; Y). GRENADA: *Sherring 137* (small form, Y, N).

In this as in *S. lineata* there are large and small forms. In both these species the field notes are too scanty to help explain these differences. Small forms have been seen from Guadeloupe, Dominica, Martinique, and Grenada. The Elliott and the Sherring specimens from Grenada have broadly elliptical-oblong to almost square laminae, with curved lower pinnae. These

* Markedly coriaceous in but one plant from St. Vincent ("Souffrière," 2,200 ft. in lava, *Eggers 6911* N), which differs also in having crowded overlapping pinnae which are deeply cordate; the wide fertile pinnae are somewhat abnormal, having cordate, sterile bases. (See also footnote under *S. violacea*, p. 380.)

specimens are not at all reduced at the apex of the lamina; the other smaller forms are but slightly reduced at the apex.

Kaulfuss described *L. Ryani* from Montserrat Island, saying he had seen only young specimens. Despite the reddish woolly character of both surfaces, it probably belongs with *striata*, from which he separates it because of oblong, smooth tubercles on the rachis at the base of the petioles; the lower, bipinnatifid, fertile pinnae suggest that he had an abnormal frond.* Raddi describes his *L. brasiliensis* as intermediate between *lineata* and *striata*. In the shape of the blade and in the small number of pinnae it seems nearer the smaller *S. striata* plants.

21. **S. Underwoodiana** Broadh. nom. nov.

Lomaria Boryana of American authors, not of Swartz.

Blechnum tubulare Diels (in part), in E. & P. Nat. Pfl. 1[4]: 249. 1899.

Plants terrestrial. Rhizome "a pronounced trunk,† though mostly underground," the scales 3–3.5 cm. long, linear, rigid, erect, shining, dark brown with a light margin, the whole appearing tobacco brown. Sterile fronds 85–100 cm. long; stipes 18–36 cm. long, often angulate, marked almost throughout by vestigial pinnae, the scales smaller, soon deciduous, suddenly broadened at the base, and mixed with tangled fibrillose deciduous ones, the position of the fallen ones marked by fine points as in *S. rufa;* lamina 58–70 cm. long, 25–32 cm. wide, oblong or broadly elliptical, abruptly reduced at the base (the lower pinnae 4–8 cm. long, type D, with vestigial pinnae), but little reduced toward the apex, the terminal pinna 10–12 cm. long; pinnae 20–30-jugate, narrowly lanceolate to narrowly oblong, straight or slightly curved near their apices, the apex gradually acute to acuminate, the upper pinnae broadly adnate or dilated on the lower side at their bases, the lower ones free in at least half the lamina, the bases never auricled, rounded, sessile to very short-petioled, 15–20 cm. long, 18–24 mm. wide; margins entire, not revolute; leaf tissue rigid-herbaceous,

* It is possible that the bipinnatifid character may refer to such an abnormality as that mentioned under *S. Schiedeana;* the whole genus *Struthiopteris* does not contain a single species with a bipinnatifid *sterile* frond.

† According to Professor Underwood; Jenman says it is one or more feet high. Professor Underwood thought that Jenman had modified this statement to include *L. Boryana* Sw., which has a caudex 2–3 feet high. A plant now growing at the New York Botanical Garden, which was brought back by Professor Underwood in 1903, has (January 1912) a densely scaly crown 3 cm. high and about 3 cm. broad.

smooth to shining below; costae* flattened on the under side, naked or with reduced scales, the surface never araneous; veins not raised below, the vein spaces 10–14 to 1 cm. Sporophyls (in the only complete one seen) 110 cm. long; stipes 30–40 cm. long, marked at least part way by vestigial pinnae; lamina about 67 cm. long, abruptly reduced at the base, somewhat reduced at the apex; pinnae about 30-jugate, 16–30 cm. long, 3–4 mm. wide, heavy, the upper ones decurrent on the lower side, the lower with occasional basal protuberances;† sporangia dark brown; indusium quite regularly lacerate, and occasionally so to the base. [PLATE 28. This illustration includes a tracing from one of Jenman's unnumbered specimens, showing the usual reduction of the basal pinnae in the sterile lamina.]

Type in the New York Botanical Garden herbarium, collected at New Haven Gap, Jamaica, altitude 5,500 feet, *L. M. Underwood 985*, February 4, 1903.

SPECIMENS INCLUDED: JAMAICA: Base of John Crow Peak, altitude 5,000–5,500 ft., *Underwood 2431* (Y). "Morse's Gap," *Harris 7598* (Y).

This species has long been confused with the species *Boryana* (*Onoclea Boryana* Sw.), originally described from Africa. The original illustration‡ shows a very different plant with fewer, short, elliptical, distant pinnae; the original description mentions an arboreous stem, four feet high, and ovate-oblong pinnae which are obtuse and 5–10 cm. long. Even the descriptions of this species by American authors have been influenced by those of the African *Boryana;* e. g., Jenman describes the Jamaican plant as having an arboreous trunk. It has therefore been necessary to describe the Jamaican species, giving it a new name, *S. Underwoodiana*, for Professor L. M. Underwood, who collected

* In the other species the costae are definitely raised on the lower side; in this the shining costae look as if smoothed or ironed down.

† See the footnote under *S. violacea*, p. 380.

‡ Bory de St. Vincent, Voy. 2, p. 194, *pl. 32;* a copy is in the Astor Library, New York City; a tracing has been placed in the New York Botanical Garden herbarium.

A small plant, probably *S. Underwoodiana*, was brought to the New York Botanical Garden conservatories by Professor F. S. Earle from Jamaica in 1902. It lived about nine years but never seemed vigorous. In 1911 it had a rhizome 3–5 cm. in diameter, 3 cm. high, and 7 sterile fronds less than 30 cm. high, which were 5–10-jugate only. There were no fertile fronds. The plant in size and number of the pinnae suggested *S. Shaferi;* the laminae were less reduced at the base than in *S. Shaferi*, and the pinnae could hardly be called auricled on the lower side.

the plant in Jamaica. The stem description given above is quoted from a letter by Professor Underwood. He brought back a specimen of the rhizome, but it could not be found during the writing of this paper. He mentioned it as growing "on the summit of the higher ridges, above 5,000 feet, and not common."

22. **S. varians** (Fourn.) Broadh. comb. nov.

Lomaria varians Fourn. Mex. Pl. 1: 113. 1872.

Blechnum varians C. Chr. Ind. Fil. 161. 1905.

Plants terrestrial. Rhizome (not seen). Sterile fronds 60–90 cm. long; stipes 12 cm. or more (incomplete in the cotype at the New York Botanical Garden), apparently not angulate, maroon, the scales yellowish, early deciduous, narrowly triangular to linear, mixed with fibrillose ones; lamina 48–50 cm. long, 25–28 cm. wide, oblong, the base not reduced (type A, without vestigial pinnae), but slightly or not reduced at the apex, the terminal pinna almost as long as the lateral ones,* the rachis soon becoming naked; pinnae 15–20-jugate, straight, long-lanceolate to narrowly oblong, the apex serrate, rather abruptly long-acuminate, the base subequally rounded, free throughout, petioled, 19 cm. long, 2 cm. wide; margins cartilaginous, irregularly erose-crispate and not revolute; leaf tissue rigid-herbaceous, smooth; veins not raised, the vein spaces 15–18 to 1 cm. Sporophyls,† the stipes 15 cm. long, the "base densely chaffy with long scales," pinnae 25-jugate, with a sterile apex.

TYPE: *Bourgeau 1826;* Herb. von Heurck, no. 1420, Mexico, "Vallée de Cordoba," February 4, 1866 (Y).

DISTRIBUTION: Known from the type locality only.

23. **S. violacea** (Fée) Broadh. comb. nov.

Lomaria violacea Fée, Mém. Foug. 11: 11. *pl. 5.* 1866.

Blechnum violaceum C. Chr. Ind. Fil. 161. 1905.

Plants terrestrial. Rhizome 2–4 cm. thick (seen only in small specimens), the scales short (5 mm. or less) umber or brown-maroon. Sterile fronds of two types, (1) short and ovate or broadly lanceolate, and (2) larger and oblong, 18–100 cm. long;‡

* Abnormal in the New York Botanical Garden type number; not reduced, however, in the type number seen either at Kew or Geneva.

† As given in Fournier's incomplete description. They are lacking in the New York Botanical Garden sheets.

‡ Fée says the length may reach 100 cm.; he figures one of the "smaller" specimens which measures 118 cm.; no scale is given, however.

stipes 4–50 cm. long, clustered, somewhat angulate, the color varying from black and reddish black to dark violet, shining where naked, the younger, at least, having scales which are seemingly viscid and which dry as straight or hooked projections (appressed in one large specimen); lamina 13–44 cm. long, 7–25 cm. wide, abruptly reduced at the base (type A, without vestigial pinnae), gradually reduced at the apex, the rachis soon becoming naked and shining; pinnae 12–50-jugate, oblong and lanceolate to narrowly oblong, often opposite below, 4–10 cm. long, 8–16 mm. wide, the apex acute,* obtuse or only apparently so in the thicker forms with rolled pinnae, the bases subcordate to cordate or unequally cordate, but 1–4 of the upper pinnae adnate, the rest free, and the lower petioled; margins usually revolute,† the pinnae themselves rolled in the heavier forms; leaf tissue coriaceous in the smaller forms, membranous to rigid-herbaceous in the larger ones, costae more or less scaly, under surface smooth ;‡ veins raised below, sunken above in the coriaceous plants, the vein spaces 14–16 to 1 cm. Sporophyls 40–85 cm. long, but taller than the sterile in all complete specimens seen; lamina 20–37 cm. long; pinnae 11–25-jugate, 4–5 mm. wide, the apex obtuse or with a sterile tip 3–7 mm. long, the bases cordate, the lower pinnae distinctly petioled with spurlike protuberances;§ the margins of the very dark and heavy pinnae often with whitish spots corresponding to the vein apices; sporangia very dark brown; indusium irregularly lacerate.

* Fée says "*tunc obtusiusculis, tunc acuminatis.*" Only the smaller specimens seen show the blunt tips.

† Irregularly so and serrate in a young, membranous plant from Dominica, *Lloyd 315.*

‡ Slightly araneous below in *Duss 3710.*

§ All the fertile fronds of *S. violacea* bear curious spurlike protuberances in or near the axils of most of the lower pinnae. They are plainly discernible to the naked eye and usually 2–5 mm. long. Similar spurs are found with some of the lower pinnae in a few of the petioled species: *S. vivipara, S. Christii* (very small), *S. chiriquana* (apparently brittle and deciduous), *S. Schiedeana* (few, but interesting in connection with the twin pinnae seen in one specimen), *S. striata* (in the peculiar volcanic specimen from St. Vincent only, and as flattish glandular areas), and in *S. Underwoodiana.* Fertile fronds of *S. danaeacea* and *S. varians* were not accessible after this character was noted. It does not occur in any of the non-petioled species. (It is present in the fertile lamina of U. S. National Herbarium no. 575235, but there are indications that it does not belong with the sterile one on that sheet.) Hooker (Spec. Fil. **3**: 26. 1860) in speaking of the sterile frond of *L. spectabilis* remarks upon a "remarkable, rather large, and distinct black glossy *gland* exactly resembling except in color a very common scale insect. Were it more constant," he adds, "I would consider this a distinct species." No other reference to similar growths on the rachis, either fertile or sterile, has been found; the somewhat abnormal Panama plant included in *S. chiriquana* shows occasional, elongated, glandular areas on the sterile rachis.

TYPE: Fée, Mém. Foug. 11: *pl. 5.* 1866; from Guadeloupe.

DISTRIBUTION: Known from Guadeloupe, Dominica, and Martinique.

SPECIMENS INCLUDED: GUADELOUPE: *Duss 4165* (Y), *Duss 3710* (Y). DOMINICA: Laudat, *Lloyd 315* (Y, N). MARTINIQUE: Montagne Pelée, *Duss 4163* (Y).

This species shows great variation in size, texture, and in the length and apices of the pinnae; most of the smaller coriaceous ones bear legends indicating that they are from high altitudes and the sides of volcanoes. Parallel information is wanting, however, for the larger specimens. The colored stipes and the heavy, lacerate, whitish-dotted fertile pinnae are apparently common to all mature specimens. Fée describes the sterile stipes as bearing short, remote spines, which are not present on our specimens or in his figure; the numerous projections figured on it resemble the dried, viscid scales described above.

24. **Struthiopteris vivipara** Broadh. sp. nov.

Plants terrestrial. Rhizome 3 cm. thick in the fragment seen, the scales very few, 2–2.5 cm. long, 4–6 mm. broad, brown umber, more or less plicate. Sterile fronds 85–90 cm. long; stipes 24–25 cm. long, angulate, vestigial pinnae present throughout, shining mahogany, the scales light brownish yellow, deciduous, shapeless and wholly appressed to the stipe, their attachment indicated as in *S. lineata;* lamina 64–66 cm. long, 28–30 cm. wide, oblong, abruptly reduced at the base (type A, with vestigial pinnae), not reduced at the apex, the terminal pinna 12–15 cm. long, viviparous at or very near the apex of the rachis; pinnae 15–16-jugate, oblong-lanceolate but broadest at the cordate base, straight or occasionally very slightly curved near the apex, the apex acute, never long-acuminate, the base cordate and free throughout, mostly sessile and the rachis covered by the bases of the pinnae, the lower pinnae petioled, 15 cm. long, 3–3.5 cm. wide; margins serrate, slightly or not at all revolute; leaf tissue rigid-herbaceous, the costae much like the stipe but also finely chaffy or fibrillose, the lower surface of the pinnae decidedly and finely araneous over the once forked veins; veins distinctly grooved above, raised below and more perpendicular than in most species of the genus (except the wider *S. striata* specimens), the vein spaces 12–14 to 1 cm. Sporophyls 115–125 cm. long; stipes 34–45 cm. long, vestigial pinnae barely visible; lamina 68–78 cm. long, abruptly reduced at the base, not gradually reduced at the apex; pinnae 15–17-

jugate, 15–17 cm. long, the terminal pinna 11–16 cm. long, 5–7 mm. wide, heavy, sometimes with a sterile apex 2–5 mm. long, the base cordate, petioled (lower 5 mm.), occasionally with spur-like protuberances;* the margins of the pinnae have whitish glands marking many of the vein apices as in *S. violacea;* sporangia very dark brown; indusium narrow, early deciduous, brittle, and very irregularly lacerate. [PLATE 29.]

Type in the U. S. National Herbarium, no. 575810, 575811, and in the New York Botanical Garden, collected on moist banks on the trail in the vicinity of La Palma, Costa Rica, altitude 1,450–1,550 m., *William R. Maxon 435*, May 6–8, 1906.

The type of *S. Christii* is from Costa Rica, but *S. vivipara* is evidently a very different plant. The following differences between the specimen mentioned under *S. Christii* (from Christ's herbarium) and *S. vivipara* may be noted: *S. vivipara* is oblong in shape and not reduced at the tip, the single specimen of *S. Christii* is ovate-lanceolate and gradually reduced at the tip; in *S. vivipara* the stipe and rachis are almost scurfy in appearance, owing to the fine, amorphous character of the wholly appressed scales; in Christ's sheet the scales are mainly definite, at least 1 cm. long, and appressed only at their bases, the stipes looking much like very scaly *S. lineata* stipes. The viviparous character may not prove constant, but it appears in each of the five fronds seen.

25. **S. Werckleana** (Christ) Broadh. comb. nov.

Lomaria Werckleana Christ, Bull. Boiss. II. 4: 1091. 1904.

Blechnum Werckleanum C. Chr. Ind. Fil. 161. 1905.

Plants terrestrial. Rhizome apparently subarboreous, the scales linear, 2.5–3 cm. long, shining, rigid, erect, with a darker center, tobacco brown to umber. Sterile fronds 115–140 cm. long; stipes† 58 cm. long, but slightly angulate, usually marked to the base with vestigial pinnae, the scales like those of the rhizome but smaller and soon deciduous; lamina 83–110 cm. long, 15–25 cm. wide, narrowly oblong, the base abruptly reduced (type A, with vestigial pinnae), gradually reduced at the apex, the rachis "spangled by scales" which are narrow, fibrillose, and mixed with *hoary* ones, forming fine, webbed masses on the rachis;

* See footnote under *S. violacea*, p. 380.

† All the following figures are the measurements of the only complete fronds seen: two sterile fronds and one fertile one; they are Werckle's own specimens and from Christ's herbarium.

pinnae 35–50-jugate, narrowly oblong, the apex abruptly acuminate, slightly curved, not serrate, the base cuneate to somewhat rounded, petioled in all the lower ones, 12–15 cm. long, 13–17 mm. wide; margins entire, not revolute; leaf tissue coriaceous, yellowish below when dried; lower surface deciduously araneous with yellowish fibrillose scales, the costae also with fibrillose scales; veins not prominent yet distinct, the vein spaces 18–20 to 1 cm. Sporophyls 143 cm. long; stipes 66 cm. long; lamina abruptly reduced at the base; somewhat reduced at the apex; pinnae 40–50-jugate, 22–26 cm. long, 3–4 mm. wide, curved or twisted, heavy, very much reflexed in drying, the sterile (ventral) surface not visible; sporangia brownish yellow; indusium delicate, fawn to light tan, quite regularly lacerate to the base, the margin finely fimbriate.

TYPE: *Wercklé 169*, from Costa Rica.

DISTRIBUTION: Known from Costa Rica only.

SPECIMENS INCLUDED: Several sheets without collection number from Costa Rica collected by Wercklé, now in the U. S. National Museum (no. 575241, 575242, and 575243) and in the New York Botanical Garden.

This species is conspicuously different from any other species, both the sterile and the fertile fronds. Among the several characters given in the description the white or hoary, fibrillose scales of the rachis are perhaps the most peculiar, while the long, curved, fertile pinnae, very much lighter in color (sporangia and indusia) than in any other North American species, are the most striking.

Many foreign species have been incorrectly attributed to North America; e. g., even American writers have included in their local flora *Lomaria attenuata* Willd., *L. procera* Spreng., and *L. Schomburgkii* Klotzsch. The tonguelike tips and bases of the pinnatifid leaves of *attenuata* Willd. differentiate it from *S. polypodioides* with which it has been confused. Under *Lomaria procera*, Sprengel cites *Osmunda procera* Forst. The name was first used for a New Zealand species with remote or distant pinnae, which were ovate-oblong in shape. An early picture in Labillardière gives two forms of pinnae, neither of which resembles *S. lineata* or *S. striata* with which it is most commonly confused. A fragment of the type of *L. Schomburgkii* has such characteristic pinnae that it should not be made synonymous with any North American species; under it, however, Christensen places the species *L. rufa* Spreng. and *L. Ryani* Kaulf.

There is much need of more material from Central America;

except a few specimens from Guatemala there is very little from the region between Costa Rica and Mexico. Seven of the above twenty-five species have Costa Rica or Panama as type locality; for none of these, however, have we a sufficient number of specimens to be sure that our descriptions indicate the variation that might reasonably be expected. Much that we have is worth little because of its fragmentary condition; several of the specimens given under INQUIRENDAE are from this region.

The collections recently made by J. A. Shafer indicate that Cuba offers similar rewards and difficulties.

INQUIRENDAE*

1. One sheet from Costa Rica, *Pittier 1921*, "Forêts du Barba, versant Pacifique," 2,500–2,700 m., 1890 (N), with broad elliptical pinnae a little like *S. rufa* in shape, but differing in size, coloring, and in the serrate margin with definitely marked vein apices. A young specimen, U. S. National Museum no. 834094 ("Volcan de Poas, Alfaro, San José," Costa Rica, altitude 2,300 m., 1902), may belong with this.

2. One sheet from Costa Rica collected by J. J. Cooper, U. S. National Museum no. 154303, November 1886; the slender, fertile pinnae are 25–28 cm. long, and the sori are continued on the dilated, non-petioled, *decurrent* bases of the pinnae. No petioled species has such fertile fronds.

3. One sheet from Costa Rica collected by Wercklé 1901–1905; (the specimen is an unnumbered one from Christ's herbarium and bears the name *Lomaria procera*, below which is written Lysr.). The fibrillose midribs and rachis separate it from *S. costaricensis*, *S. lineata*, and *S. striata*, to which it is nearest. The fertile leaf is lacking, though I strongly suspect it is the one mounted with the sterile frond on the U. S. National Museum sheet no. 575235.

4. One sheet (part of a sterile leaf) from Costa Rica, collected by Wercklé, U. S. National Museum no. 575240, is wrongly labeled *B. Werckleana;* it differs from the description and Christ's other specimens in texture, color, proportion, the margin, the bases of the pinnae, and in size. A pinna was sent to Christ, but he

* This section includes only the unplaced material not already discussed in connection with the various species.

found the material too incomplete to name satisfactorily. With this might be placed another fragment (one pinna) from Costa Rica, *Hoffman 36*.

5. Two sheets from Guatemala, *Cook & Griggs 161* and *578*, near the Finca Sepacuite, Alta Verapaz (N); the long terminal pinnae suggest the smaller forms of *S. Schiedeana*, but they are heavier in texture and the bases of the pinnae are subcordate to cordate.

6. Two sheets (fragments) from St. Vincent, *H. H. & G. W. Smith 1023* (Y). Their coloring, their flattened, shining costae, which resemble those of *S. Underwoodiana*, and their falcate pinnae distinguish them from *S. striata*, which they otherwise suggest. They are not at all like the deeply cordate, coriaceous specimen from St. Vincent discussed under *S. striata*.

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Contributions to the Mesozoic flora of the Atlantic coastal plain—VIII. Texas*

EDWARD W. BERRY

(WITH PLATES 30–32)

The following annotated list of fossil plants is based on a small collection from the Woodbine formation, made at Arthurs Bluff on the Red River in Lamar County, Texas, by Doctors T. W. Stanton and L. W. Stephenson in 1911 for the U. S. Geological Survey.

The presence of fossil plants in the Cretaceous strata of Lamar County has been known for half a century as is shown by a letter from Dr. B. F. Shumard, dated Oct. 2, 1860, read before the Academy of Science of St. Louis at its session of Nov. 5, 1860, and quoted on page 140 of the printed Transactions.† Dr. B. F. Shumard, at that time state geologist of Texas, states that his brother Dr. G. G. Shumard discovered numerous dicotyledonous leaves resembling the modern leaves of *Salix*, *Ilex*, *Laurus*, etc., in the Cretaceous yellowish sandstones of Lamar County near the Red River. These were undoubtedly from the locality now known as Arthurs Bluff, which has furnished the subsequent collections. Dr. Shumard further states that these plants were sent to Leo Lesquereux for determination, but if sent they were apparently lost in transit.‡

When R. T. Hill took up the study of the Texas Cretaceous, new collections were made between 1880 and 1885 at Arthurs Bluff and at Denison, the latter a locality originally discovered by Dr. Shumard. These collections were, according to Hill, sent to the U. S. National Museum and lost in storage. Finally in Hill's great work on the Texas Cretaceous§ Dr. F. H. Knowlton furnished a report on collections of fossil plants from the Woodbine formation

* Published with the permission of the Director of the U. S. Geological Survey.

† Trans. Acad. Sci. St. Louis **2**: 140. 1868.

‡ Lesquereux, Cretaceous Flora, U. S. Geol. Surv. Terr. **6**: 11. 1874.

§ Hill, Geography and Geology of the Black and Grand Prairies, Ann. Rep. U. S. Geol. Surv. **21**[7]: 314–318. *pl. 39.* 1901.

at Arthurs Bluff, Lamar County; Woodbine, Cooke County; and Denison, Grayson County.

The largest of these collections is the one from Arthurs Bluff, which was made in 1894 by Dr. T. Wayland Vaughan. The plants are preserved in a fragmentary state in a yellowish sandy clay or loose sandstone. Dr. Knowlton identified the following species from this locality:

Aralia Wellingtoniana Vaughanii Knowlton
Benzoin venustum (Lesq.) Knowlton
Diospyros primaeva Heer
Ficus glascoeana Lesq.?
Liriodendron pinnatifidum Lesq.?
Myrica longa (Heer) Heer
Phyllites rhomboideus Lesq.
Platanus primaeva Lesq.
Sapindus Morrisoni Heer?
Salix deleta Lesq.
Viburnum robustum Lesq.

The collection from Woodbine in Cooke County was made by G. H. Ragsdale and is reported as containing:

Andromeda Pfaffiana Heer
Cinnamomum ellipsoideum Sap. & Mar.
Cinnamomum sp.?
Diospyros primaeva Heer
Eugenia primaeva Lesq.
Phyllites aristolochiaeformis Lesq.?

The collection from Denison, Grayson County, was made by T. V. Munson from two outcrops in that town, Munson Hill, from which Dr. Knowlton is unable to identify any forms specifically, and Rhamey Hill, from which the following are recorded:

Cinnamomum Heerii Lesq.
Diospyros Steenstrupi Heer
Inga cretacea Lesq.
Laurus proteaefolia Lesq.
Liquidambar integrifolium Lesq.
Magnolia Boulayana Lesq.
Magnolia speciosa Heer
Populus sp.?
Salix sp.?

Confining any comments to the collection studied by the writer we may note that out of a total of 27 species, three species and one variety of which are new, seventeen are forms either described or recorded from the Dakota group. It is greatly to be regretted that no very precise stratigraphic significance can be attached to any particular units of the Dakota group flora, since the Dakota group materials have been recognized over a very wide area in a more or less unscientific way and no careful stratigraphic-paleobotanic work has ever been carried out.

Since the Woodbine formation of northeastern Texas undoubtedly represents deposits laid down during a part of Dakota group time, they should naturally contain this large Dakota group element. If we judge by the range of the Woodbine species

that occur in the Cretaceous of the Atlantic coastal plain as shown in the appended table, the Woodbine represents an earlier rather than a later part of the Dakota interval. Eleven Woodbine species are found in the lower Raritan, eleven in the upper Raritan, eleven in the Magothy, and fifteen in the lower Tuscaloosa of western Alabama. From extensive studies of this large lower Tuscaloosa flora it seems probable that its basal portion represents the time equivalent of the uppermost Raritan, and there are sixteen species from these two horizons represented in the Woodbine collection. The small representation in the upper Tuscaloosa is without chronologic significance, since it merely reflects our present lack of knowledge of the constituents of this upper Tuscaloosa flora. The presence of only five of these species in the Black Creek-Middendorf beds of the Carolinas, while it probably indicates that the latter are in the main younger than the Woodbine,* would be more impressive if all five were not extremely abundant and wide-ranging forms, all being present in either the lower Raritan or the lower Tuscaloosa. Only two species are found in the lower Eutaw, the older character of the Woodbine flora being particularly emphasized by the absence of the characteristic gymnosperms, such as *Araucaria bladenensis* Berry, *Araucaria Jeffreyi* Berry, *Sequoia*, *Cunninghamites*, *Tumion*, the two species of *Androvettia*, etc. In fact, the Woodbine flora is remarkable by reason of the almost total absence of gymnosperms, only two forms, *Brachyphyllum macrocarpum formosum* and *Podozamites lanceolatus*, being represented in the present collection, and none being recorded in the previous collections studied by Knowlton.

Our knowledge of the Woodbine flora is much too limited for any positive conclusions regarding the botanical or physical conditions that attended its development; and larger collections are much to be desired, since the small collections studied by the writer and by Dr. Knowlton indicate the presence in these beds of a large and varied, even if fragmentarily preserved, flora. This, when collected and studied, may be expected to show the relation between the Dakota flora and that from the Cheyenne sandstone of

* I regard the Middendorf as the equivalent of a part of the Tuscaloosa and the typical Black Creek as representing the upper Tuscaloosa and lower Eutaw.

southern Kansas, so that eventually we will know what are the older and what the younger elements in the Dakota flora.

Seven species in the Arthurs Bluff collection extend northward along the Atlantic coastal plain to western Greenland, and four additional species in the lists of Woodbine plants quoted from Knowlton's report have a like distribution. These are sufficient to indicate that climatic conditions at this time in the Upper Cretaceous were much more uniform than they are at the present time. A consideration of the large collections from the Tuscaloosa formation of Alabama shows that the latter, when compared with the contemporaneous Greenland flora, while essentially similar, contains additional elements that may legitimately be regarded as tropical or subtropical. It seems evident that while the differences in climate between Greenland and Texas were infinitely less in Woodbine time than they are today, there was a distinct

	Dakota group	Lower Tuscaloosa	Upper Tuscaloosa	Lower Raritan	Upper Raritan	Magothy	Black Creek-Middendorf	Lower Eutaw
Andromeda Novae-caesareae Hollick	....	×	....	....	×	×	×	×
Andromeda Snowii Lesq.	×	....	....	....	....	....	....	....
Aralia Wellingtoniana Lesq.	×	....	....	×	....	....	....	....
Benzoin venustum (Lesq.) Kn.?	×	....	....	....	....	....	....	....
Brachyphyllum macrocarpum formosum var. nov.	....	×	....	....	....	×	×	×
Cinnamomum membranaceum (Lesq.) Hollick	×	....	....	....	....	×	....	....
Colutea primordialis Heer	....	....	....	×	×	....	....	....
Cornophyllum vetustum Newb.	....	×	....	×	....	....	....	....
Eucalyptus Geinitzi (Heer) Heer	×	×	×	×	×	×	×	....
Ficus daphnogenoides (Heer) Berry	×	×	....	×	×	×	×	....
Laurophyllum minus Newb.	....	....	....	....	×	....	....	....
Laurus plutonia Heer	×	×	....	×	×	×	×	....
Liriodendron quercifolium Newb.	....	....	....	×	....	....	....	....
Magnolia speciosa Heer	×	×	....	×	....	×	....	....
Malapoenna falcifolia (Lesq.) Kn.?	×	×	....	....	....	×	....	....
Myrica emarginata Heer	×	×	....	×	×	....	....	....
Oreodaphne alabamensis sp. nov.	....	×	....	....	....	....	....	....
Palaeocassia laurinea Lesq.	×	×	....	....	....	....	....	....
Podozamites lanceolatus (L. & H.) Braun	×	....	....	×	×	×	....	....
Populus harkeriana Lesq.	×	....	....	....	×	....	....	....
Rhamnus tenax Lesq.	×	×	....	....	....	....	....	....
Rhus reddilformis sp. nov.	....	....	....	....	....	....	....	....
Sapindus Morrisoni Lesq.	×	×	....	....	×	×	....	....
Sterculia lugubris Lesq.?	×	....	....	....	....	....	....	....
Tricalycites papyraceus Newb.	....	×	....	×	×	?	....	....
Viburnum robustum Lesq.?	×	....	....	....	....	....	....	....
Zizyphus lamarensis sp. nov.	....	×	....	....	....	....	....	....

increase in mean annual temperatures in proceeding southward from the latitude of Greenland.

Conditions comparable to those of Woodbine time occur in those areas where the tropical flora extends many degrees farther than its normal range to the north or south of the equator, becoming more or less mixed with temperate elements to form the flora typical of temperate rain forests like that of New Zealand, so often cited. The extension of the Upper Cretaceous flora southward across the present torrid zone indicates less torrid conditions during the Cretaceous than in the present day tropical belt, so that it will be extremely difficult, even if it ever becomes possible, to discriminate between subtropical and warm temperate Cretaceous climates, and to assert with any confidence that the imaginary line separating the two shall be placed in the South Atlantic or Middle Atlantic states or still farther to the northward.

The appended table shows the range in the United States of the species discussed in the following notes:

GYMNOSPERMAE

PODOZAMITES LANCEOLATUS (L. & H.) F. Braun

Zamia lanceolata Lind. & Hutton, Foss. Fl. **3**: 121. *pl. 194.* 1836.
Podozamites lanceolatus F. Braun, in Münster, Beitr. Petref. **2**[6]: 33. 1843.

This form, described originally from the English Oolite, has a very wide recorded geological and geographical range. A large number of Jurassic varieties have been described, and indistinguishable forms occur in both the Lower and Upper Cretaceous of both America and Europe. In the Upper Cretaceous it occurs in the Raritan formation from Long Island to Maryland and in the Cenomanian of Bohemia, as well as in the Dakota group of Kansas.

While it is almost inconceivable that these similar detached leaflets from such various horizons represent a single botanical species, no criteria other than the unsafe one of stratigraphic position are available for their discrimination. The Arthurs Bluff collection contains a single perfect and typical leaflet, and whether it is specifically identical with all of the other forms referred to this species or not, it is of great interest in showing the presence of a gymnosperm of this type in the Woodbine flora.

Brachyphyllum macrocarpum formosum var. nov.

Brachyphyllum macrocarpum Berry, Bull. Torrey Club **37**: 183. 1910; **38**: 420. 1911. (Not Newberry, 1896.)

DESCRIPTION: Slender elongated twigs, pinnately branched, covered with medium-sized, crowded, appressed leaves, spirally arranged. Leaves bluntly pointed, relatively smooth, thick. (PLATE 30.)

In the consideration of the various specimens that have been referred to *Brachyphyllum macrocarpum* Newberry, a very considerable variation within certain fixed limits is at once obvious. This variation is usually one of size, the more slender specimens being at the same time more elongated and smoother. This has been frequently noted by the writer and is commented upon in print by Dr. F. H. Knowlton,* who in discussing the later forms (from Wyoming) suggests that the species on the verge of extinction became smaller in its proportions.

In studying the material from the South Atlantic and Gulf States a constant difference in size was noticed by the writer. This may reflect a slight difference in climatic conditions, and all of the forms may be interpreted as the variations of a single species, in fact, one of Newberry's figures† of a Raritan specimen is approximately the same size as the forms from the Montana group of the West and is associated with the normal, stout, club-shaped type. That the variety has no particular stratigraphic significance is indicated by its abundance at a horizon as old as the basal Tuscaloosa formation in Alabama and its presence in the Woodbine formation. In general, however, it occurs at later and more southern horizons than the type. This might be ascribed to the fact that only the slender and more elongated terminal twigs are preserved at these localities; but such an explanation is regarded as improbable, since the same reasoning should hold good for the areas where only the thicker twigs have been found.

The remains are usually much macerated and broken, and this is eminently true of the three specimens from Arthurs Bluff. The warrant for describing them as a new variety is furnished by the

* Knowlton, Bull. U. S. Geol. Surv. 163. 29. *pl. 4. f. 5, 6.* 1900.

† Newberry, Mon. U. S. Geol. Surv. **26**: 51. *pl. 7. f. 1–7.* 1896 (see *f. 7*).

discovery of a large and rather complete specimen in the Magothy formation of Maryland. The latter shows the terminal part of two approximately parallel and curved twigs, about 12 cm. in length, united proximad. These in their thickest portion are only 6 mm. in diameter. At intervals of from 3 mm. to 5 mm., subopposite lateral branches are given off in a pinnate manner. These are relatively much elongated, curved, and slender, averaging about 4 cm. in length by 2 mm. in diameter, bluntly pointed and not tapering to any appreciable extent. These have been infrequently observed to fork pseudo-dichotomously, and at times they give off toward their distal ends tiny lateral branchlets less than a centimeter in length and about one millimeter in diameter. The general proportions are thus decidedly different from the parent type. The leaves are slightly smaller and smoother and somewhat more elongated in their relative proportions, at the same time lacking the apical papillae and the convergent striae. The new variety is much more graceful than the type in appearance, and in its general aspect suggests the Lower Cretaceous genus *Arthrotaxopsis*. The most closely allied form appears to be one from the Albian of Portugal, described by Saporta* as *Brachyphyllum obesiforme elongatum*. There is also considerable resemblance to *Brachyphyllum crassicaule* Fontaine of the Patapsco formation in Maryland and Virginia. Remains of this new variety are associated with the type in Maryland; they are abundant throughout the Tuscaloosa of Alabama, ranging upward into the basal part of the Eutaw formation in both Alabama and western Georgia.

MYRICALES (?)

MYRICA EMARGINATA Heer

Myrica emarginata Heer, Fl. Foss. Arct. **6**[2]: 66. *pl. 4. f. 2.* 1882. —Lesquereux, Mon. U. S. Geol. Surv. **17**: 67. *pl. 12. f. 1.* 1892.—Newberry, Mon. U. S. Geol. Surv. **26**: 62. *pl. 41. f. 10, 11.* 1896.—Berry, Bull. N. J. Geol. Surv. **3**: 104. *pl. 10. f. 5.* 1911.

Leaves obovate in outline, widest at the rounded-truncate and more or less emarginate apex. Margins entire, narrowing to the cuneate base. Midrib medium stout, inclined to be somewhat

* Saporta, Fl. Foss. Portugal 176. *pl. 31. f. 14.* 1894.

flexuous. Secondaries about five thin subopposite pairs, diverging from the midrib at angles of about 45 degrees, camptodrome.

A single but entirely typical leaf of this species is contained in the collection. It is identical with the remains of this species as they occur in the basal part of the Tuscaloosa formation in Alabama and in the Dakota sandstone of Kansas. It is relatively wider and more robust than the type material from the Atane beds of Greenland, being intermediate in character between the type material and that referred to this species from the Raritan formation of New Jersey. Its reference to the genus *Myrica* is entirely problematical.

SALICALES

POPULUS HARKERIANA Lesq.

Populus harkeriana Lesq. Fl. Dakota Group 44. *pl. 46. f. 4.* 1892.
—Hollick, Mon. U. S. Geol. Surv. **50**: 49. *pl. 7. f. 31.* 1907.

This species was described by Lesquereux from the Dakota group at Fort Harker, Kansas, and was subsequently recorded by Hollick from the Cretaceous material (Raritan or Magothy) in the terminal moraine near Tottenville, Staten Island. The Arthurs Bluff collection contains a single specimen and its counterpart showing half of a large typical leaf of this species. There is also an undeterminable species of the *Populus* type in the collection.

URTICALES

FICUS DAPHNOGENOIDES (Heer) Berry

Proteoides daphnogenoides Heer, Phyll. Crét. Nebr. 17. *pl. 4. f. 9, 10.* 1866.

Ficus daphnogenoides Berry, Bull. Torrey Club **32**: 327. *pl. 21.* 1905.

This species was described originally from the Dakota group of Nebraska by Heer. It is a widespread and common Upper Cretaceous form ranging from Marthas Vineyard to Alabama in the Atlantic coastal plain and from Northwest Territory to Kansas and Nebraska in the western interior. It is abundant in the lower part of the Tuscaloosa formation in western Alabama. The Arthurs Bluff collection contains three fragmentary specimens showing the characteristic attenuated tip of this species.

Figs are apparently much less abundant in the Woodbine than

in the Tuscaloosa formation on the eastern shore of the Cretaceous Mississippi embayment.

RANALES

MAGNOLIA SPECIOSA Heer

Magnolia speciosa Heer, Neue Denks. Schw. Gesell. **23**: 20. *pl. 6. f. 1; pl. 9. f. 2; pl. 10. f. 1.* 1869.—Knowlton, Ann. Rep. U. S. Geol. Surv. **21**[7]: 318. 1901.

A single small leaf of this species is contained in the collections from Arthurs Bluff. *Magnolia speciosa* was described by Heer from the Cenomanian of Moravia, and subsequently it has been found to have a wide range in North America, being recorded from the Dakota group and from the Raritan and Magothy formations along the Atlantic coast. In Alabama it is confined to the lower part of the Tuscaloosa formation, where it is abundant. It was reported by Knowlton (loc. cit.) in 1901 in a small collection from the Woodbine formation at Rhamey Hill, Denison, Texas, made by T. V. Munson of Denison.

LIRIODENDRON QUERCIFOLIUM Newberry

Liriodendron quercifolium Newb. Bull. Torrey Club **14**: 6. *pl. 62. f. 1.* 1887; Fl. Amboy Clays 81. *pl. 51. f. 1–6.* 1896.—Berry, Bull. N. J. Geol. Surv. **3**: 138. *pl. 17. f. 1.* 1911.

This species was described a quarter of a century ago by Newberry from the middle Raritan of Woodbridge, N. J., to which locality it has been hitherto confined. It is a very characteristic leaf with a broadly emarginate summit and three or four pointed laterally directed lobes on each side, separated by relatively narrow sinuses. The venation is of the *Liriodendron* type with strong secondaries.

While the present determination is based upon a single incomplete specimen, it is undoubtedly a fragment of this species and is about as complete, as well as similar in outline and size, as Newberry's *fig. 2*. It shows the two upper lateral lobes of one side of a leaf, separated by a sharp, not deep sinus, separated from a larger but similar basal lateral lobe by a deeper and broader sinus, and is absolutely characteristic.

Knowlton (loc. cit.) has recorded *Liriodendron pinnatifidum* Lesq., doubtfully, and *Liriodendron Snowii* Lesq., positively, from

Arthurs Bluff, but neither of these species is represented in the present collection. Both are characteristic forms and so different that there is no possibility of confusing them with the species just discussed.

ROSALES

PALAEOCASSIA LAURINEA Lesq.

Palaeocassia laurinea Lesq. Fl. Dakota Group 147. *pl. 64. f. 12.* 1892.

This species was described from the Dakota group of Kansas, to which it has been hitherto confined. As interpreted by Lesquereux, its describer, the remains represented leaflets of a *Cassia*-like plant, although so far as I know, all have been found detached, the only basis for considering them leaflets rather than leaves being their slight inequilateral form.

A single entire leaf is contained in the collection from Arthurs Bluff. It is identical with the type material from Kansas in size, outline, and venation, with the exception that it is slightly wider (2–5 mm.) with a consequently somewhat fuller and more rounded base. It has recently been detected in the lower Tuscaloosa of Alabama.

COLUTEA PRIMORDIALIS Heer

Colutea primordialis Heer, Fl. Foss. Arct. **6**[2]: 99. *pl. 27. f. 7–11; pl. 43. f. 7, 8.* 1882.

This well-marked little species was described from the Atane beds of Greenland. It occurs in strata at least as old as the upper Raritan in New Jersey and is present in both the Dakota and Magothy floras.

The collection from Arthurs Bluff contains a single complete and in every way typical leaf of this species.

SAPINDALES

SAPINDUS MORRISONI Lesquereux

Sapindus Morrisoni Lesq.; Heer, Fl. Foss. Arct. **6**[2]: 96. *pl. 40. f. 1; pl. 41. f. 3; pl. 43. f. 1a, b; pl. 44. f. 7, 8.* 1882.—Knowlton, Ann. Rep. U. S. Geol. Surv. **21**[7]: 317. 1901.

This species was described by Heer from the Atane beds of west Greenland and identified with the manuscript species of the same name which Lesquereux had given to a Dakota group

plant from Morrison, Colorado. It is a common Dakota group form occurring also in the Raritan, Tuscaloosa, and Magothy formations of the Atlantic coastal plain. Fragmentary specimens occur in the collection from Arthurs Bluff, where it was also recorded by Knowlton in 1901 (loc. cit.).

Rhus redditiformis sp. nov.

DESCRIPTION: Leaves compound, probably trifoliate. Leaflets petiolate, ovate in outline, with bluntly pointed tips, cuneate bases, and entire or undulate margins forming occasional distal shallow broadly rounded lobules separated by broad shallow sinuses. Terminal leaflet nearly equilateral, about ⅓ larger than the lateral leaflets, about 4 cm. in length by 2 cm. in maximum width, which is about midway between the apex and the base; petiolule 5 mm. long; midrib stout, prominent; secondaries thin, 5 or 6 alternate pairs, branching from the midrib at angles of about 50°, curving slightly upward, anastomosing close to the entire margin. Lateral leaflets inequilateral, the outer limb of the lamina being slightly wider and fuller than the inner limb; petioles shorter than that of the terminal leaflet, 2–3 mm. in length, diverging from the latter at angles of about 70°; in outline and venation similar to the terminal leaflet, but smaller and showing a tendency to develop slight irregularities in the margin, especially toward their tips. (PLATE 31, FIG. 2.)

This species is obviously new and is named from its rather striking resemblance to the European early Tertiary species *Rhus reddita* Saporta* from Aix in southeastern France. Several Cretaceous species of *Rhus* have been described from horizons as old as the Woodbine, the Dakota group of Kansas furnishing three well-marked species with pinnate leaves, one of which *Rhus Uddeni* Lesquereux† is reported by Ward from the so-called Cheyenne sandstone at Belvidere, Kansas. A small toothed species has been described by Velenovsky‡ from the Cenomanian sandstone of Bohemia as *Rhus cretacea*, although this name was already in use for a very different Cretaceous species described by Heer§ from the Senonian of Quedlinburg in Saxony and recorded by Hollick‖ from the Upper Cretaceous of Long Island. The Woodbine

* Saporta, Études **1**: 124. *pl. 13. f. 2, a, b.* 1862.

† Lesquereux, Mon. U. S. Geol. Surv. **17**: 154. *pl. 57. f. 2.* 1892.

‡ Velenovsky, Fl. Böhm. Kreidef. **4**: 7. *pl. 4. f. 7–12.* 1885.

§ Heer, Fl. Quedlinburg 14. *pl. 3. f. 11.* 1872.

‖ Hollick, Mon. U. S. Geol. Surv. **50**: 87. *pl. 33. f. 2.* 1907.

species is readily distinguishable from all of the foregoing and adds a well-marked and probably trifoliate Cretaceous form to this genus, which is so largely developed during Tertiary times. In the existing flora *Rhus* is a prominent element with upwards of 150 species, which are for the most part natives of warm temperate and tropical regions. A modern species with almost identical foliage is *Rhus villosa* L., a south African form.

OCCURRENCE: Woodbine formation, Arthurs Bluff, Red River, Lamar County, Texas.

COLLECTION: U. S. National Museum.

Zizyphus lamarensis sp. nov.

DESCRIPTION: Leaves elliptical in outline, 4.5 cm. to 5 cm. in length by 3 cm. in maximum width about midway between the apex and the base, slightly nearer the latter; base full and rounded; lateral margins full and rounded; apex rounded, slightly less full than the base; margin with regular but shallow crenate teeth becoming less prominent toward the base. Midrib slender but prominent, straight. Lateral primaries one on each side, diverging from the midrib at its extreme base at an acute angle (about 10°), thin, slightly curved inward above their middle, joining a secondary in the apical part of the leaf. Secondaries from the midrib two or three alternate thin pairs in the apical region, camptodrome; secondaries from the lateral primaries five or six in number, on the outside, curved, camptodrome; the lowest secondary is longest and branches at the most acute angle (about 10°) and from the extreme base, each successively higher secondary subtending a slightly larger angle and following a somewhat shorter course. Internal tertiaries more or less percurrent, marginal ones similar to the secondaries from the primaries in their arrangement and course, thin and camptodrome. (PLATE 31, FIG. 1.)

This handsome species of an undoubted *Zizyphus* is unfortunately represented by very scant material. It is entirely distinct from any described Cretaceous species and is much closer to various Tertiary and still existing forms. It has recently been detected in the lower Tuscaloosa of Alabama.

RHAMNALES

RHAMNUS TENAX Lesquereux

Rhamnus tenax Lesq. Am. Jour. Sci. **46**: 101. 1868; Fl. Dakota Group 170. *pl. 38. f. 6.* 1892.

This species was described many years ago by Lesquereux from the Dakota sandstone of southern Kansas and subsequently reported by Bartsch from the same horizon in Iowa. It is abundant in the lower Tuscaloosa of western Alabama, and a single characteristic specimen is contained in the Arthurs Bluff collection.

MALVALES

STERCULIA LUGUBRIS Lesquereux?

Sterculia lugubris Lesq. Cret. and Tert. Fl. 81. *pl. 6. f. 1–3.* 1883.

This species is apparently represented at Arthurs Bluff by the single specimen figured, which agrees very well with the Dakota group forms of *Sterculia lugubris*. It is queried since it may represent a slender almost parallel-margined form of *Aralia Wellingtoniana Vaughanii* Knowlton, which is so common at this locality. (PLATE 31, FIG. 3.)

THYMELEALES

BENZOIN VENUSTUM (Lesq.) Knowlton

Lindera venusta Lesq. Fl. Dakota Group 95. *pl. 16. f. 1, 2.* 1892.
Benzoin venustum (Lesq.) Knowlton, Bull. U. S. Geol. Surv. **152**: 47. 1898; Ann. Rep. U. S. Geol. Surv. **21**: 317. *pl. 39. f. 2.* 1901.

This is a trilobate Dakota group species, described originally from Kansas and identified by Knowlton in 1901, in a collection made at Arthurs Bluff by T. W. Vaughan.

The present collection contains two fragmentary specimens which I have little hesitancy in referring to this species, especially as it has already been reported from this locality.

MALAPOENNA FALCIFOLIA (Lesq.) Knowlton?

Litsea falcifolia Lesq. Fl. Dakota Group 97. *pl. 11. f. 5.* 1892.
Malapoenna falcifolia (Lesq.) Knowlton, Bull. U. S. Geol. Surv. 182: 142. 1898.

This species was described from the Dakota group of Kansas by Lesquereux and recorded by the writer from the Magothy formation in New Jersey. The Arthurs Bluff collection contains a single specimen of the lower half of a leaf which is doubtfully identified as this species. It is clearly distinguishable from

Malapoenna horrellensis Berry,* of the Black Creek formation in North Carolina, by its suprabasilar primaries and cuneate base but may possibly be a fragment of *Cinnamomum Newberryi* Berry.†

Oreodaphne alabamensis sp nov.

DESCRIPTION: Leaves of large size, ovate in general outline, ranging from 13 cm. to 20 cm. in length, and from 4.75 cm. to 7 cm. in maximum width, which is at a point about midway between the apex and the base. From the point of greatest width the margins curve, both distad and proximad, in a very full curve, narrowing rather abruptly to the acuminate tip and also to the more or less decurrent base. Midrib stout, curved. Lateral primaries opposite, one on each side, branching from the midrib at an acute angle a considerable distance above its base, rather straight in their course, thinner than the midrib. Above the primaries there is an interval, and then about six pairs of thin, curved, approximately parallel, camptodrome secondaries branch from the midrib at acute angles. The lateral primaries give off on the outside numerous regularly spaced and approximately parallel curved camptodrome secondaries, the latter feature serving to distinguish this species from other fossil species of this genus, and from *Cinnamomum*, *Cocculus*, or other genera with somewhat similar leaves with which it might be compared. Texture coriaceous. (PLATE 32.)

This fine large species is represented at Arthurs Bluff by fragmentary but characteristic specimens. The foregoing description and the figure are drawn from abundant and complete material collected by the writer from the lower Tuscaloosa of western Alabama. It shows considerable variation in size and some in outline, the latter dependent on whether the leaf is widest nearer to or farther from the base. In the latter case the distal part is more fully rounded and abruptly contracted to the acuminate tip, while the base is more gradually narrowed and finally cuneate rather than decurrent. In the former case the apical portion is more gradually narrowed and the base is full and rounded abruptly, decurring to the petiole.

This species is markedly different from previously described fossil forms but may be matched by several modern tropical American species of *Oreodaphne*. The genus *Oreodaphne* of Nees,

* Berry, Bull. Torrey Club 37: 198. *pl. 24. f. 1–9.* 1910.

† Berry, loc. cit. 38: 423. 1911.

which is exclusively American in the existing flora, is made a subgenus of *Ocotea* Aublet by Pax in Engler and Prantl's Die Natürlichen Pflanzenfamilien. The latter genus, which for paleobotanical purposes may be considered as composite, has about two hundred modern species, occurring chiefly in the American tropics and ranging from southern Florida to Brazil and Peru, but with some representation (subgenus *Mespilodaphne* Nees) in the Canary Islands, South Africa, Madagascar, and the Mascarene Islands.

The single existing American species reaching the United States, whose habit and environment may be taken as typical for the whole genus, is found in Florida, southward from capes Canaveral and Romano along the shores and islands with the exception of some of the western keys, making its best growth in the rich, moist, hammock lands near the coast.

CINNAMOMUM MEMBRANACEUM (Lesq.) Hollick

Paliurus membranaceus Lesq. Am. Jour. Sci. **46**: 101. 1868.
Cinnamomum membranaceum Hollick, Mon. U. S. Geol. Surv. **50**: 75. *pl. 29. f. 5, 6.* 1907.

Two leaves of this species, identical with Hollick's *fig. 6*, except that one is slightly smaller, were found at Arthurs Bluff. The previous occurrences are the Dakota group and Glen Cove, Long Island (Raritan or Magothy formations).

LAURUS PLUTONIA Heer

Laurus plutonia Heer, Fl. Foss. Arct. **6²**: 75. *pl. 19. f. 1d, 2–4; pl. 20. f. 3a, 4–5; pl. 28. f. 10, 11; pl. 42. f. 4b.* 1882.

This species was described by Heer from the Atane beds of west Greenland and a large number of somewhat variable and fragmentary specimens were figured. Subsequently it was recorded from a very large number of Cretaceous plant beds, so that its range, both geographical and geological, is rather extensive. A number of these records are not entirely above suspicion, and this appears to be especially true of the forms from the Cenomanian of Bohemia identified by Velenovsky.

Laurus plutonia is rare in the Raritan, the writer having found it only near the top of that formation. It is abundant in the

overlying Magothy formation from New Jersey to Maryland. In the southern coastal plain it occurs in the Middendorf beds of South Carolina and ranged from the base of the Tuscaloosa formation upward into the Eutaw formation in the Alabama area.

A single complete and characteristic leaf and several fragments are contained in the Arthurs Bluff collections.

LAUROPHYLLUM MINUS Newberry

Laurophyllum minus Newb. Fl. Amboy Clays 86. *pl. 16. f. 7–9.* 1896.

This species was described from the Raritan formation of New Jersey and found by the writer in the upper part of that formation only. In the absence of venation characters in both the type and later collected material its identification is always more or less uncertain; and it may represent a variety of *Laurus plutonia* Heer or some of the forms that have been referred to *Myrica longa* Heer, although in general it is wider than the latter and more elongated and less symmetrical than the former. A single specimen is present in the collection from Arthurs Bluff.

MYRTALES

EUCALYPTUS GEINITZI (Heer) Heer

Eucalyptus Geinitzi Heer, Fl. Foss. Arct. 6[2]: 93. *pl. 19. f. 1c; pl. 4. f. 1, 13.* 1885.

This widespread and characteristic Upper Cretaceous species is found from the base of the Raritan formation of New Jersey upward into the Black Creek and Middendorf beds of the Carolinas. The type locality is the Cenomanian of Moravia, but it has also been recorded from the Atane beds of west Greenland and from the Dakota group of the West. In the Alabama Cretaceous it has been collected from only the lower part of the Tuscaloosa formation.

A single characteristic leaf is present in the collections from Arthurs Bluff.

UMBELLALES

ARALIA WELLINGTONIANA Lesq. emend.

Aralia Wellingtoniana Lesq. Fl. Dakota Group 131. (in part) *pl. 21. f. 1.* 1892 (not *pl. 22. f. 2, 3,* which are referred to *Aralia*

Saportana).—Newberry, Fl. Amboy Clays 114. *pl. 26. f. 1.* 1896.—Berry, Bull. N. J. Geol. Surv. **3**: 202. *pl. 25. f. 7.* 1911 (not Smith, Geol. Coastal Plain Ala. 348. 1894).

This handsome species is characterized by its describer as being palmately 3- to 5-lobed, but it certainly seems significant that all of the forms from the Raritan formation are invariably 3-lobed and that the 5-lobed forms from the Dakota sandstone which Lesquereux referred to this species are indistinguishable from his species *Aralia Saportana*, which occurs at the same horizon and, in part at least, at the same locality.

This is the most abundant form collected at Arthurs Bluff, there being fifteen specimens in the one small collection, several nearly complete leaves being present. These are all trilobate with toothed margins and agree exactly with the Raritan leaves of this species and with the trilobate leaves from the Dakota sandstone like the one figured by Lesquereux on *pl. 21. fig. 1.*

In the light of our present knowledge *Aralia Wellingtoniana* may be recharacterized in the following terms:

Leaves variable in size, 10–20 cm. in length by 8 to 15 cm. in maximum width from tip to tip of the lateral lobes, average size about 15 cm. in length by 11 cm. in width; coriaceous, palmately deeply trilobate, with a rapidly narrowed and more or less extended decurrent base; lobes long, lanceolate, widest in the middle and narrowing below, somewhat abruptly acuminate, the median slightly the longest, diverging at an angle of about 30°, separated by sinuses extending more than halfway to the base, narrowly rounded; margins entire below and for varying distances upward, passing gradually into dentate-serrate teeth, one to each secondary or sometimes less in number, prominent in some specimens where they are more or less extended and directed upward, separated by wide shallow sinuses. Primaries stout, suprabasilar, the median slightly larger than the laterals. Secondaries numerous, thin, regular, subparallel, ascending, since the angle of their divergence from the primaries averages about 33°, but slightly curved in their course, ultimately craspedodrome in distal parts of leaf, where the margin is toothed, and camptodrome in the basal half of the leaf, where the margin is entire. Areolation indistinct, reticulate, of quadragonal or polygonal meshes. The smaller leaves are relatively shorter and broader, with less extended lobes and more open and less deep sinuses.

The present species may be distinguished from *Aralia cotton-*

dalensis Berry of the Tuscaloosa formation, with which it was confused by Ward (in Smith, Geol. Coastal Plain Ala. 348. 1894), by the shorter more conical lobes of the latter, its broadly rounded base and more crenate marginal teeth.

Aralia Saportana as here restricted to the 5- or 6-lobed forms is very close to *Aralia Wellingtoniana* and may be regarded as an offshoot from it. The fact that the two are associated in the Dakota group only and not in New Jersey or Texas rather controverts regarding them as the variants of a single species; and suggests that at least geographic varieties are represented, particularly as the trilobate form is so abundant at Arthurs Bluff that it is hard to conceive of trees with 5-lobed leaves growing in the vicinity whose foliage failed to be preserved. Furthermore, as the writer correlates the deposits, both the New Jersey Raritan and the Texas Woodbine at Arthurs Bluff are older than the Dakota sandstone in that area in Kansas from which Lesquereux described the 5-lobed forms, so that there is every reason for regarding *Aralia Saportana* as the direct descendant of *Aralia Wellingtoniana*.

The present species is also very similar to *Aralia decurrens* Velenovksy* from the Cenomanian of Bohemia, which, however, has relatively narrower and more elongated lobes, with coarser teeth and deeper sinuses.

In reporting on a collection made by Vaughan at Arthurs Bluff and now in the U. S. National Museum, Knowlton† mentions *Aralia Wellingtoniana Vaughanii* var. nov. as the most abundant form observed. This variety was distinguished from the type by its trilobate form, more slender lobes and entire margins. This variety is not contained in the present collection.

CORNOPHYLLUM VETUSTUM Newberry

Cornophyllum vetustum Newb. Fl. Amboy Clays 119. *pl. 19. f. 10.* 1896.—Berry, Bull. N. J. Geol. Surv. **3**: 196. 1911.

This species has heretofore been known only in the lower and middle Raritan beds in the New Jersey area, although it is present in undescribed collections from the lower Tuscaloosa made by

* Velenovsky, Fl. Böhm. Kreidef. **3**: 11. *pl. 4. f. 5–7.* 1884.

† Knowlton, in Hill, Ann. Rep. U. S. Geol. Surv. **21**[2]: 317. 1901.

the writer near Glen Allen, Ala. It is very similar to species of *Cornus* described from the Dakota group, the Atane beds of west Greenland, and the Magothy formation of Maryland. It is represented in the collection from Arthurs Bluff by one good specimen.

VIBURNUM ROBUSTUM Lesq.?

Viburnum robustum Lesq. Fl. Dakota Group 120. *pl. 20. f. 4–6.* 1892.—Knowlton, Ann. Rep. U. S. Geol. Surv. **21**[7]: 317. 1901.

Knowlton records a single nearly perfect leaf of this Dakota group species from Arthurs Bluff. The same species is represented by fragments in the present collection.

ERICALES (?)

ANDROMEDA NOVAE-CAESAREAE Hollick

Andromeda Novae-caesareae Hollick in Newb. Fl. Amboy Clays 121. *pl. 42. f. 9–12, 28–31.* 1896.

This well marked species, which appears in the upper Raritan formation of New Jersey and is so abundant at somewhat later horizons in the coastal plain southward as far as Alabama, is represented by three complete leaves in the collections from Arthurs Bluff. These Texas leaves are of the type with a rounded apex so common in the Black Creek beds of North Carolina.

While the species is found in both the Black Creek beds of North Carolina and in the Middendorf beds of South Carolina, both horizons considerably younger than the Raritan, it appears to be confined to the basal part of the Tuscaloosa formation in western Alabama.

ANDROMEDA SNOWII Lesquereux

Andromeda Snowii Lesq. Fl. Dakota Group 117. *pl. 17. f. 16.* 1892.

This Dakota group species, previously recorded from Kansas, is represented by a single specimen from Arthurs Bluff. It resembles the lanceolate leaves of the preceding species but is broader with less numerous and much less ascending secondaries.

INCERTAE SEDIS

TRICALYCITES PAPYRACEUS Hollick

Tricalycites papyraceus Hollick, Bull. Torrey Club **21**: 63. *pl. 180. f. 8.* 1894.

This very characteristic tri-alate fossil is abundant in the middle and upper Raritan formation of New Jersey. It occurs sparingly in the overlying Magothy formation and is very common in the lower part of the Tuscaloosa formation in western Alabama. It is abundant at Arthurs Bluff, the present collection containing eight typical specimens, some of them complete. They are in exact agreement with the Tuscaloosa forms and demonstrate what is discussed at length in my manuscript of the Tuscaloosa flora that the approximately parallel longitudinal venation of the wings is really a more or less forked and anastomosing venation, thus allying these fossils in a remote way with such modern genera as *Vatica* of the Dipterocarpaceae.

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Explanation of plates 30–32

PLATE 30

Brachyphyllum macrocarpum formosum Berry var. nov., Sullivans Cove, Maryland.

PLATE 31

FIG. 1. *Zizyphus lamarensis* Berry sp. nov., Arthurs Bluff, Texas.
FIG. 2. *Rhus reddififormis* Berry sp. nov., Arthurs Bluff, Texas.
FIG. 3. *Sterculia lugubris* Lesquereux, Arthurs Bluff, Texas.

PLATE 32

Oreodaphne alabamensis Berry sp. nov., Cottondale, Ala.

Mitosis in living cells

CHESTER ARTHUR DARLING

Practically all of the work done on the phenomena of cell division has been done with material that has been fixed, imbedded in paraffin, sectioned, and finally stained; this method has been subjected to various criticisms and it has been maintained that figures observed in the fixed and stained cells are artifacts, stages that do not exist in nature. Although these criticisms have been squarely met in many cases, undoubtedly much valuable data might be obtained by devoting more time to the study of the living cell.

Very favorable material for studying cells in the living condition has been found in the young anthers of some of the maples. Twigs of the red maple, *Acer rubrum*, with flower buds were gathered on February 10 before any swelling of the buds had taken place. Twigs about 6–10 inches long were brought into the laboratory, placed in a glass of water and kept near the window, the water was changed every day or two and the base of the stem often cut afresh. To examine the pollen mother cells the bud scales were removed and the young flowers placed on a slide and mounted in water; if the anthers are long enough it is best to cut them crosswise with a sharp knife; by pressing down on the cover glass the mass of spore mother cells are forced out of the anther and are then readily observed. In the case of the red maple the mother cells began to divide on February 17, one week from the time they were picked from the tree, whereas those left on the tree did not divide until one week later; the advantage of bringing them into the laboratory is that one may examine them every day and so determine in what stage of growth or division the cells may be. I was able to observe the chromosomes in the equatorial plate, and in polar view was able to count as many as 40, fixed and stained material showing practically the same number. An advantage in the living cell at this stage is that the chromosomes are placed about equally distant from each other and not drawn close together

as is often the case when fixed and stained. The spindle was clearly marked and the spindle fibers distinguishable; anaphase and telophase stages could be readily observed; in fact practically all of the division figures to be found in fixed and stained material were observed in these living cells. The spireme is rather thin in this form, so that it could not be detected in the living cell; the nucleolus with a budlike attachment was plainly seen. The cytoplasm in *Acer rubrum* is not so dense as to obstruct or confuse the view of the nucleus as it is in some forms.

Various stages in the division of the daughter nuclei were as clearly seen as were those of the mother cell; these daughter nuclei divide very soon after the first division of the mother cell, without the formation of the new cell wall. Within twenty-four hours after the first cells were seen to have begun division practically all of the mother cells in the material had formed the four distinct spores, showing that these stages go on rapidly.

Attempts were made to induce the cells to complete their divisions by placing them in sugar solutions of various strengths from 2 per cent to 15 per cent, but in no case did a cell continue to divide after being forced out of the anther.

Twigs of the silver maple, *Acer saccharinum*, were brought into the laboratory on the same dates as those of the red maple; although the cytoplasm is denser and although the division figures were not so clearly marked, yet practically all of the stages observed in the red maple were seen in the pollen mother cells of this species. In the Norway maple, *Acer platanoides*, the division of the pollen mother cells takes place much later in the season. On March 20 twigs were brought into the laboratory, and on March 23 the mother cells divided. Various division figures were observed in this species together with a very conspicuous budlike process on the large nucleolus. The cytoplasm in this species is more dense and more granular than that in *Acer rubrum*, so that the chromosomes and spindle fibers were not so clearly seen. The mass of spore mother cells does not force out of the anther until the cells are nearly ready to divide, usually within a day or two, whereas in the red maple the tapetal cells become detached from the endothecium of the anther at least two weeks before division.

In the European larch, *Larix decidua*, I have observed the

pollen mother cells in stages of division, although the presence of numerous starch grains and of granules in the cytoplasm often obscures the definiteness of the figures.

Because of the simplicity of the means any one interested in seeing the chromosomes, nucleoli, and stages in the division of the living cell may do so with an ordinary compound microscope with a 1/6 in. objective. The only difficulties that may arise are: to obtain the flower buds before division of the pollen mother cells has taken place, which may be four weeks or more before the flowers open, as was the case in the maples this year; the other difficulty may be in the density of the cytoplasm, but this varies with different species and with different anthers of the same species.

These few observations are recorded to emphasize the fact that many of the phenomena presented in fixed and stained material can easily be verified as existing in the living cell.

COLUMBIA UNIVERSITY.

INDEX TO AMERICAN BOTANICAL LITERATURE

(1912)

The aim of this Index is to include all current botanical literature written by Americans, published in America, or based upon American material; the word America being used in the broadest sense.

Reviews, and papers that relate exclusively to forestry, agriculture, horticulture, manufactured products of vegetable origin, or laboratory methods are not included, and no attempt is made to index the literature of bacteriology. An occasional exception is made in favor of some paper appearing in an American periodical which is devoted wholly to botany. Reprints are not mentioned unless they differ from the original in some important particular. If users of the Index will call the attention of the editor to errors or omissions, their kindness will be appreciated.

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Bitter, G. Weitere Untersuchungen über die Gattung *Acaena*. Repert. Sp. Nov. **10**: 489–501. 5 My 1912.

Discusses several species from Central and South America.

Blake, S. F. The forms of *Peltandra virginica*. Rhodora **14**: 102–106. *pl. 94*. 14 Je 1912.

Bragg, L. M. The museum herbaria. Bull. Charleston Mus. **8**: 43–49. My 1912.

Brown, P. E. Some bacteriological effects of liming. Centralb. Bakt. Zweite Abt. **34**: 148–172. 15 My 1912.

Claassen, E. Alphabetical list of lichens collected in several counties of northern Ohio. Ohio Nat. **12**: 543–548. 7 Je 1912.

One hundred and twenty-eight species listed.

Coker, W. C. The plant life of Hartsville, S. C. Jour. Elisha Mitchell Sci. Soc. **27**: 169–205. *pl. 1–15*. 16 F 1912.

East, E. M. Inheritance of color in the aleurone cells of maize. Am. Nat. **46**: 363–365. Je 1912.

East, E. M., & Hayes, H. K. Heterozygosis in evolution and in plant breeding. U. S. Dept. Agr. Plant. Ind. Bull. 243: 7–58. *pl. 1–8*. 5 Je 1912.

Evans, A. W. *Hepaticae* of Puerto Rico—XI. *Diplasiolejeunea*. Bull. Torrey Club **39**: 209–225. *pl. 16, 17 + f. 1, 2*. 8 Je 1912.

Faull, J. H. The cytology of *Laboulbenia chaetophora* and *L. Gyrinidarum*. Ann. Bot. **26**: 325–355. *pl. 37–40*. Ap 1912.

Fawcett, W., & Rendle, A. B. New plants from Jamaica. Jour. Bot. **50**: 177–182. *pl. 518.* Je 1912.
New species are described in *Peperomia* (1) and *Pilea* (9).

Fedde, F. *Corydalis Allenii*, eine neue Art aus der Verwandtschaft der *Corydalis Scouleri*, von Washington. Repert. Sp. Nov. **10**: 478, 479. 5 My 1912.

Fedde, F. Neue Arten aus der Verwandtschaft der *Corydalis aurea* Willd., von Nord-Amerika—V. Repert. Sp. Nov. **10**: 479, 480. 5 My 1912.
Corydalis macrorrhiza sp. nov. is also described.

Fernald, M. L., & Wiegand, K. M. A blunt-spiked variety of *Carex scoparia*. Rhodora **14**: 115–116. *pl. 94.* 14 Je 1912.

Fraser, C. G. Induced hermaphrodism in *Acer Negundo* L. Torreya **12**: 121–124. *f. 1.* 11 Je 1912.

Frothingham, E. H. Second-growth hardwoods in Connecticut. U. S. Forest Serv. Bull. 96: 9–70. *pl. 1–6 + f. 1–3.* 8 My 1912. [Illust.]

Graebener, L. *Kleinia pendula* DC. Monats. Kakteenk. **22**: 69. 15 My 1912. [Illust.]

Griffon, E., & Maublanc, A. Les *Microsphaera* des chênes. Bull. Soc. Myc. France **28**: 88–104. *pl. 3–5.* 15 Ap 1912.
Discusses certain American species.

Groth, B. H. A. The F_2 heredity of size, shape, and number in tomato fruits. New Jersey Agr. Exp. Sta. Bull. 242: 3–39. *pl. 1–3.* 30 Mr 1912.

Hall, H. M., & Hall, C. C. A Yosemite flora. i–vii + 1–282. San Francisco. 8 Ap 1912.
"A descriptive account of the ferns and flowering plants, including the trees, of the Yosemite National Park."

Harper, R. A. Some current conceptions of the germ plasm. Science II. **35**: 909–923. 14 Je 1912.

Harris, J. A. A first study of the influence of the starvation of the ascendants upon the characteristics of the descendants—I. Am. Nat. **46**: 313–343. Je 1912.

Hayes, H. K. Correlation and inheritance in *Nicotiana Tabacum*. Connecticut Agr. Exp. Sta. Bull. 171: 3–45. *pl. 1–5.* My 1912.

Heimerl, A. Zur Kenntnis der Nyctaginaceen-Gattung *Okenia*. Verh. Zool.-Bot. Gesells. Wien **61**: 461–467. *f. 1, 2.* 28 F 1912.

Heller, A. A. The flora of the Ruby Mountains—V. Muhlenbergia **8**: 49–58. *pl. 5 + f. 4, 5.* 31 My 1912.
Includes *Castilleja lapidicola* sp. nov. and *Siphonella* gen. nov.

Hill, A. W. A visit to the West Indies. Kew Bull. Misc. Inf. **1912**: 166–189. My 1912.

Contains some information relating to the fungi and other plants of these islands.

Hitchcock, A. S. *Gramineae.* In Jepson, W. L., A flora of California. 82–189. 30 Ap 1912.

Includes keys to the tribes, genera, and species; one new species each in *Aristida, Agrostis, Poa,* and *Glyceria; Notholcus* Nash, gen. nov.

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Jepson, W. L. A flora of California. 65–192. 30 Ap 1912.

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A synopsis of a lecture delivered before the Ottawa Field Naturalists' Club.

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Rehder, A. *Rhododendron carolinianum*, a new rhododendron from North Carolina. Rhodora **14**: 97–102. 14 Je 1912.

Robinson, W. J. A taxonomic study of the *Pteridophyta* of the Hawaiian Islands—I. Bull. Torrey Club **39**: 227–248. *pl. 18–20.* 8 Je 1912.

Sackett, W. G. Bakteriologische Untersuchungen über die Stickstoffbindung in gewissen Bodenarten von Colorado. Centralb. Bakt. Zweite Abt. **34**: 81–115. *f. 1–5.* 15 My 1912.

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Includes new species in *Spiranthes* (2), *Cranichis* (1), *Oreorchis* (1), *Lepanthes* (1), *Epidendrum* (3), and *Campylocentrum* (1) from Central America.

Setchell, W. A. Algae novae et minus cognitae, I. Univ. Calif. Pub. Bot. **4**: 229–268. *pl. 25–31.* 29 My 1912.

Describes *Hapterophycus canaliculatus* Setchell & Gardner, *Besa papillaeformis* Setchell, *Baylesia plumosa* Setchell, gen. et spp. nov.; *Fauchea Fryeana* Setchell, *Dudresnaya bermudensis* Setchell, *Leptocladia conferta* Setchell, and *Weeksia Fryeana* Setchell, spp. nov.

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